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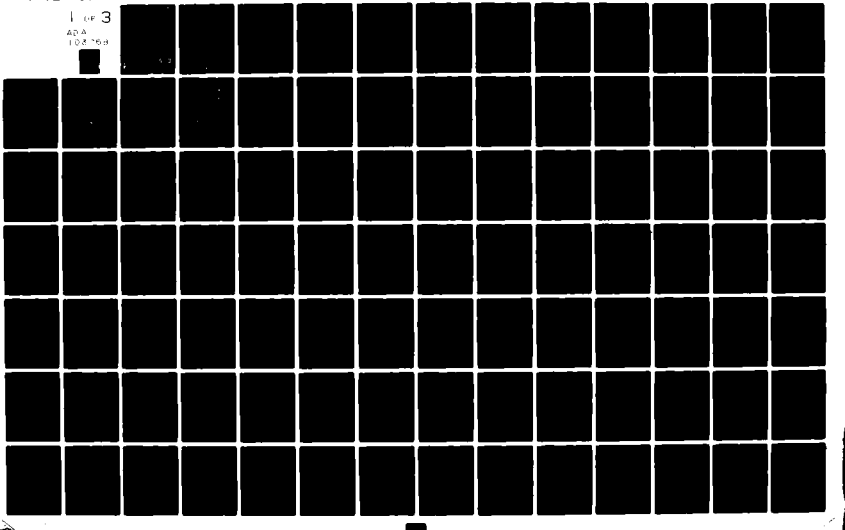

REGIONAL ECONOMIC DEVELOPMENT IN THE SOVIET UNION, TWO CASE STUDIES: THE BALTIC AND CENTRAL ASIA

by
James Bert Streets

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Economics)
in The University of Michigan
1981

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Professor Saul H. Hymans

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(14) AFIT-CI

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
81-50	AD-A103	768

4. TITLE (and Subtitle) — (6)

Regional Economic Development in the Soviet Union, Two Case Studies: The Baltic and Central Asia.

5. TYPE OF REPORT & PERIOD COVERED: THESIS/DISSERTATION

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s) — (10)

James Bert Streets

8. CONTRACT OR GRANT NUMBER(s): (9) Doctoral Thesis

9. PERFORMING ORGANIZATION NAME AND ADDRESS

AFIT STUDENT AT: The University of Michigan

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS

AFIT/NR
WPAFB OH 45433

(11)

12. REPORT DATE: 1981

13. NUMBER OF PAGES: 250

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

(12) 264

15. SECURITY CLASS. (of this report): UNCLASS

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

23 JUN 1981

18. SUPPLEMENTARY NOTES

APPROVED FOR PUBLIC RELEASE: IAW AFR 190-17

Fredric C. Lynch
FREDRIC C. LYNCH, Major, USAF
Director of Public Affairs
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Wright-Patterson AFB, OH 45433

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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ABSTRACT

REGIONAL ECONOMIC DEVELOPMENT IN THE SOVIET UNION, TWO CASE STUDIES: THE BALTIC AND CENTRAL ASIA

by

James Bert Streets

Chairman: Morris Bornstein

This is a study to evaluate two issues regarding regional development in the Soviet Union. The first issue is to identify the principal contributors to regional economic growth. The second is to analyze the impact of selected Soviet policies on regional development. The growth records of the Baltic and Central Asia are examined both in terms of factor input growth, and in terms of productivity growth. The two aspects of Soviet policy analyzed are the regional impact of non-regional policies (e. g., maintaining high rates of growth and a powerful military) and the impact of policies that are basically regional in nature (e. g., equalizing living standards across geographic regions).

The method of study is to formulate and estimate a linear simultaneous model for a Soviet economic region. The data consist of pooled cross-sectional time-series information covering the republics of the two regions (excluding Turkmenia) from 1960 to 1977. The data set is included in an appendix. The causes of growth in the non-agricultural sectors are analysed by applying the methods of

Edward F. Denison to the estimation results from the model's production functions. The same basic approach is attempted for agriculture, but poor estimation results limit success. Issues bearing on changes in the primary factors (capital and labor) are evaluated in the framework of the model.

The regional influences of Soviet economic policy are evaluated principally through the equations describing regional investment and consumption. The regional significance of Soviet defense policy is assessed in the investment equations of the model. The relationship between regional factor productivity, the growth objective, and investment are indirectly evaluated. The investment equations are also the vehicle to test the proposition that the Soviet authorities direct significant amounts of investment toward the objective of reducing the inequality in regional per capita net value of output. The model's consumption equations are used to test the proposition that the authorities direct resources to partially equalize regional per capita consumption levels.

The results indicate that the principal difference in the causes of non-agricultural sector growth between the Baltic and Central Asia is the substantially (30 per cent) higher returns to scale in the Baltic, due almost entirely to a much higher elasticity of output with respect to capital than in Central Asia. Consequently, in the Baltic productivity increases explain about 35 per cent of total growth of net material product in the non-agricultural

sectors, while in Central Asia the corresponding figure is only 18 per cent. There are some indications that higher productivity in the Baltic is accompanied by higher investment levels, given the sectoral composition of total national investment. There is also evidence that increases in Soviet military spending during the study period displaced more investment both in the Baltic and in Central Asia than was the general Soviet case. There is no statistical evidence that investment in the non-agricultural sectors is directed toward objectives of reducing regional differences in per capita output. However, there is evidence to suggest that poorer regions received more favorable treatment in terms of agricultural investment. There is also evidence to support the contention that Soviet policy acts to reduce regional inequality in consumption.

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CHAPTER I

INTRODUCTION

In market economies regional differences in per capita incomes tend to be relatively narrow both at low levels and at high levels of per capita income, and relatively wide at intermediate levels of development. In addition, regional per capita income differences within a given country tend to widen and then narrow during the process of economic development.[1] There are some indications that growth in centrally-planned economies also is accompanied by increasing differences in regional per capita incomes, at least during the early stages.[2] The goal of this study is to compare the growth experiences of two regions of the Soviet Union, the Baltic and Central Asia, a prosperous and a poor region, respectively, with two objectives in mind.

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[1]See Jeffery G. Williamson, "Regional Inequality and the Process of National Development: A Description of the Patterns," Economic Development and Cultural Change 13 (July, 1965, Part II), pp. 6, 9, and Felix Paukert, "Income Distribution at Different Levels of Development: A Survey of Evidence," International Labour Review 109 (August-September 1973), pp. 110-113.

[2]Ivan S. Koropekckyj, "Equalization of Regional Development in Socialist Countries: An Empirical Study," Economic Development and Cultural Change 21 (October, 1972)

The first objective is to ascertain why the Baltic grew more rapidly from the early sixties to the late seventies than Central Asia, in terms of per capita net material product (see Appendix A). The second objective is to evaluate, to the extent a two-region study permits it, some of the regional effects of Soviet economic policy.

A study of regional growth experiences in the Soviet economy seems particularly appropriate for the evaluation of regional development in centrally-planned economies, for three reasons. First, it has been more than fifty years since the introduction of central planning in 1928. Second, Soviet leadership since Lenin consistently has proclaimed the reduction of regional inequality as an economic goal, though generally it has not been of primary importance.[3] Third, the Soviet economy is a particularly good example of a centrally planned economy, because the Soviet Union's particular economic system has been imposed on the nations of Eastern Europe.

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pp. 68-86.

[3]For a discussion of Leninist nationalities policy in historical perspective, see Vsevolod Holubnychy, "Some Economic Aspects of Relations Among the Soviet Republics," in Eric Goldhagen, ed., Ethnic Minorities in the Soviet Union (New York: Praeger, 1968), pp. 52-53. The relative importance of equalizing regional development among the priorities for Soviet resource allocation is discussed in Alexander Woroniak, "Regional Aspects of Soviet Planning and Industrial Organization," in V. N. Bandera and Z. L. Melnyk eds., The Soviet Economy in Regional Perspective (New York: Praeger, 1973) pp. 273-274. See also Alex Inkeles, "Soviet Nationality Policy in Perspective," in Alex Inkeles, ed., Social Change in Soviet Russia (Cambridge: Harvard University Press, 1968), P. 249.

Studies of regional differences in the Soviet Union must consider the enormous geographical size of the USSR. It seems fairly intuitive that countries of considerable size with large, ethnically and culturally diverse populations distributed disparately across their area have greater potential for regional economic inequalities than do small, compact nations with fairly homogenous populations. At the very least, the difference is one of macro-regional as opposed to micro-regional comparison. Before an overview of this study, it is appropriate to discuss the regionalization basis selected for use and the particular rationale for choosing the Baltic and Central Asia as cases for the estimation of an econometric model of Soviet regional growth.

The Soviet Academy of Sciences delimited 18 economic regions for the Soviet Union in 1962.[4] These regions, shown in Map 1, are the geographic frame of reference for this study. They have been chosen for three reasons. First, the Soviet regionalization process is fairly similar to Western approaches, differing mainly in the emphasis on the "territorial-production complex," and on the spatial aspects of the objective of economic growth.[5] Second,

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[4]The Republic of Moldavia is not assigned to any economic region.

[5]Compare George J. Demko and Roland J. Fuchs, eds., Geographical Perspectives in the Soviet Union (Columbus: Ohio State University Press, 1974), pp. 101-102, with, e. g., A. J. Brown and E. M. Burrows, Regional Economic Problems (London: George Allen and Unwin, Ltd., 1977), pp. 14-16, and Harry W. Richardson, Regional Growth Theory

SOVIET ECONOMIC REGIONS – 1977, MAP – I

1. BALTIC
2. BELORUSSIA
3. SOUTH – WEST
4. MOLDAVIA
5. SOUTH
6. DONETS-DNEPR
7. BLACK EARTH CENTRE
8. CENTRE
9. NORTHWEST
10. NORTH CAUCASUS
11. VOLGA
12. VOLGA – VYATKA
13. TRANS – CAUCASIA
14. URAL
15. KAZAKHSTAN
16. CENTRAL ASIA
17. WEST SIBERIA
18. EAST SIBERIA
19. FAR EAST

SOURCE: JOHN C. DEWDNEY, A GEOGRAPHY OF THE SOVIET UNION, 3rd. Ed., P. 61

since one of the objectives of this study is to evaluate some aspects of Soviet regional policy, it is essential that the regional boundaries used in the study conform to those used by Soviet planners.[6] Third (and a compelling reason) the published data are available on the same territorial basis as Soviet administrative units.[7]

The Baltic and Central Asian regions (shown in Maps 2 and 3, respectively) have been chosen for study for two reasons. First, the Baltic is a prosperous, industrialized, geographically small, well-integrated region located close to Soviet population and industrial centers while Central Asia is a poor, agrarian, geographically large, poorly-integrated region located far from other population and industrial centers. Furthermore, during the period covered in this dissertation, the difference in per capita net material product of the Baltic and Central Asia increased.[8] Second, the Baltic is composed of three republics (Estonia, Latvia, and Lithuania) and Kaliningrad Oblast of the

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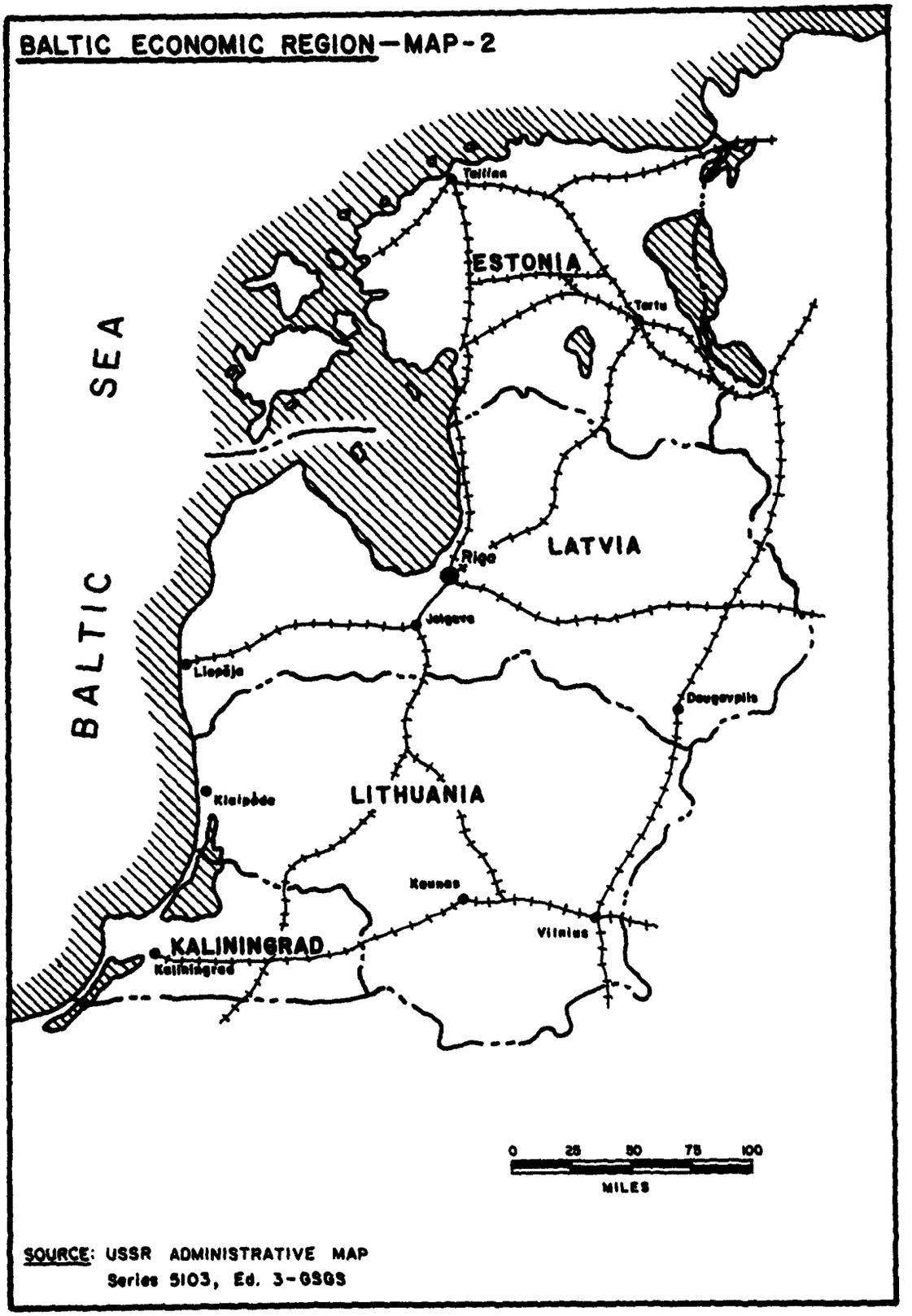
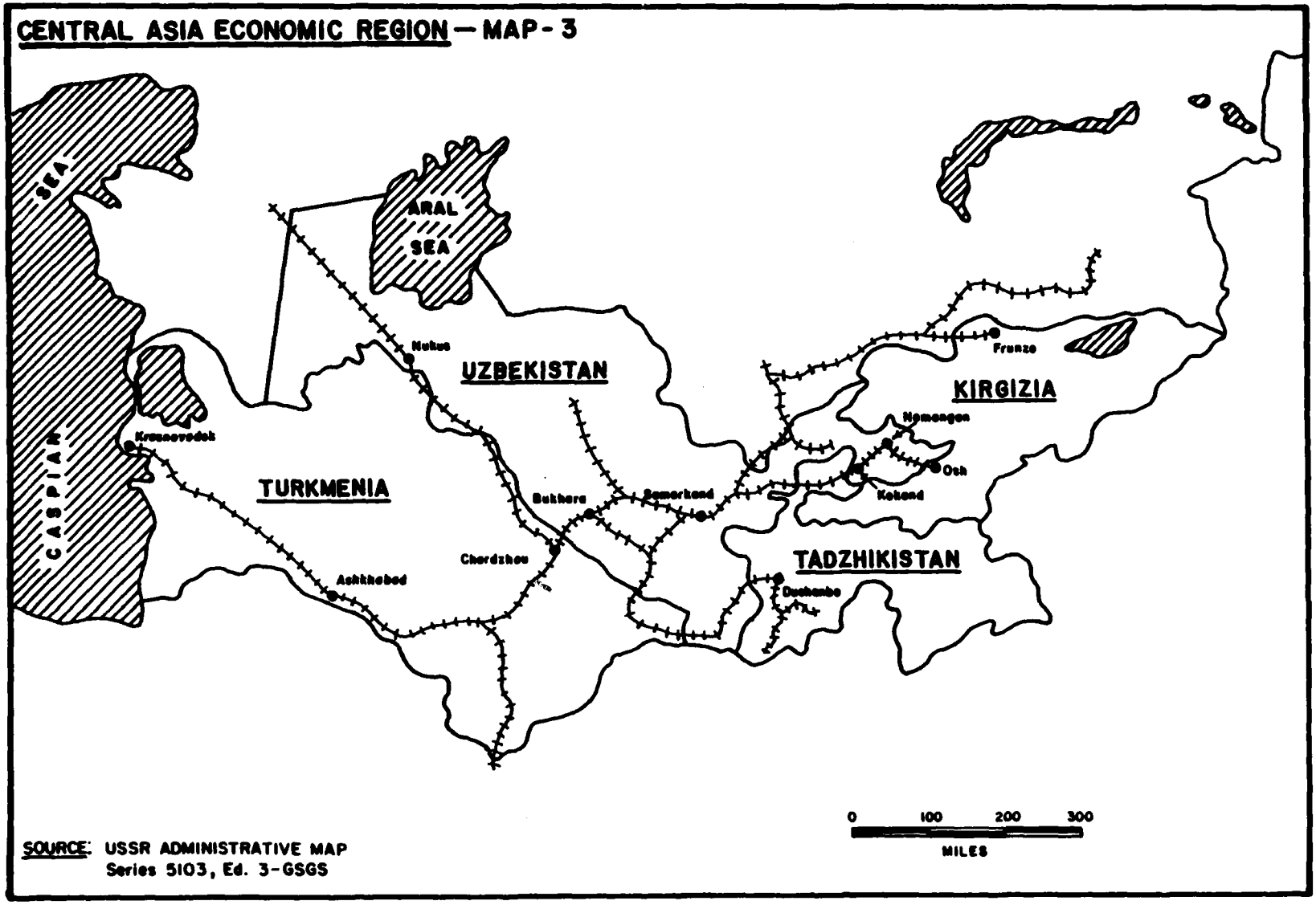
(London: Macmillan, 1973), p. 6.

[6]This point is made convincingly in Bohdan Gruchman, "Delimitation of Macroregions in Centrally Planned Economies," in Andrew F. Burghardt, ed., Development Regions in the Soviet Union, Eastern Europe, and Canada (New York: Praeger, 1975), p. 7.

[7]In practice, coverage over the period of this study is available only for some of the republics; data are published on a sub-republic basis only sporadically.

[8]Hans-Jürgen Wagener, Regional Output Levels in the Soviet Union (new York: Radio Liberty Committee, No. 41, 1971), pp. 14-15.


BALTIC ECONOMIC REGION—MAP-2
BALTIC SEA
Tallinn
ESTONIA
Tartu
LATVIA
Riga
Jelgava
Liepāja
Daugavpils
Klaipėda
LITHUANIA
Kaunas
Vilnius
KALININGRAD
Kaliningrad
0 25 50 75 100
MILES
SOURCE: USSR ADMINISTRATIVE MAP
Series 5103, Ed. 3-GSGS


CENTRAL ASIA ECONOMIC REGION — MAP - 3
CASPIAN SEA
ARAL SEA
UZBEKISTAN
TURKMENIA
KIRGIZIA
TADZHIKISTAN
Nukus
Krasnovodsk
Bukhara
Samarkand
Chardzhou
Ashkhabad
Frunze
Namangan
Osh
Kokand
Dushanbe
0 100 200 300
MILES
SOURCE: USSR ADMINISTRATIVE MAP
Series 5103, Ed. 3-GSGS

RSFSR,[9] and Central Asia is composed of four republics (Kirgizia, Tadzhikistan, Turkmenia, and Uzbekistan). Therefore, a data series may be constructed for each of these regions by combining republic-level data.[10]

The effective period of this study is from 1960 to 1977, because continuous republic data coverage can be taken back only to 1960 (1961 for some variables), and data for years subsequent to 1977 are not generally available.[11] There are also gaps in the data coverage and inconsistencies in data definition, both between republics and within the series for a given republic for different years. The details of these problems are discussed in Appendix A, and econometric techniques used to compensate for the resultant problems in estimation are covered in the first section of Chapter III and in Appendix B.

This study develops a macroeconometric model designed to illuminate certain aspects of growth in the two regions

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[9]Kaliningrad Oblast is not included in fitting the model developed below, due to insufficient data.

[10]Because of severe limitations in the published data, Turkmenia has been excluded in the model estimation process.

[11]Extending some aspects of this study beyond 1977 may not be feasible, since the Soviets have curtailed publication of some regional information. In many cases, the last actual reported year was 1975, but trends and related published material allow projections for a short while. However, this becomes progressively riskier, the longer is the period of projection. It seems reasonable to say that some aspects of this model cannot be carried much beyond 1977 without risk of considerable error. In particular, wage and labor data are disaggregated past 1975 based on projections, and some of the information to construct the $PRIO_t$ variable (used in the investment equation) is based on projections beyond 1976.

Table I.1

PER CAPITA NMP GROWTH RATES (ALL SECTORS)
(Average Annual Percentage Rate of Growth)

Period	The Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
60-65	7.3	5.7	5.5	3.2	4.8	5.3
65-70	8.2	6.7	6.4	3.5	4.6	3.1
70-77	4.0	4.6	4.4	3.6	a2.3	2.1
60-77	6.2	5.5	5.5	3.4	b3.8	3.3

a: 1970-1976 b: 1960-1976

Table I.2

TOTAL NMP GROWTH RATES
(Average Annual Percentage Rate of Growth)

Period	The Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
60-65	8.8	7.2	7.4	7.7	8.5	9.3
65-70	9.4	7.7	7.6	6.8	7.7	6.5
70-77	4.9	5.6	5.4	6.8	a4.7	5.3
60-77	7.4	6.7	6.6	7.0	b6.8	6.8

a: 1970-1976 b: 1960-1976

chosen, as well as certain aspects of effective Soviet policy toward the regions. Estimation is by pooled cross-sectional time-series data for each region, with cross-sectional units being the involved republics. The regional

Table I.3

POPULATION GROWTH RATES

Period	The Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
60-65	1.4	1.3	1.2	3.7	3.5	3.8
65-70	1.2	1.0	1.1	3.2	3.0	3.3
70-77	.9	.9	.9	3.0	a2.3	3.1
60-77	1.1	1.0	1.1	3.3	b2.9	3.4

a: 1970-1976 b: 1960-1976

economies are disaggregated into two "sectors," agricultural and all non-agricultural material production. Together these sectors account for all regional net material product. Regional differences in the rate of growth of per capita income are illustrated in Table I.1. Tables I.2 and I.3 considered with Table I.1 make it clear that a substantial part of the difference between per capita NMP growth in the Baltic and in Central Asia is due to differences in the population growth rates. Tables I.4, I.5, and I.6 show that in the non-agricultural sectors of the economy, growth in the Baltic is less dependent on growth of primary factor inputs than is growth in those sectors of Central Asia. That is, productivity increases have been greater in the Baltic. Given this information, the model developed and estimated below attempts to explain changes in output (net material product) and in the primary inputs over the 17 year

period for which data are available. Changes in per capita net material product (NMP) can then be combined with changes in population to assess the causes of growth in per capita NMP, as is done above.

Table I.4

NMP GROWTH RATES (NON-AGRICULTURE)

Period	The Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
60-65	11.5	8.6	9.6	a9.6	9.7	11.4
65-70	12.4	9.5	9.4	8.7	10.6	8.6
70-77	7.3	6.4	6.4	8.2	b6.1	b7.4
60-77	10.0	7.9	8.3	c9.0	d8.6	d9.0

a: 61-65 b: 70-76 c: 61-77 d: 60-76

Table I.5

CAPITAL STOCK GROWTH RATES (NON-AGRICULTURE)

Period	The Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
60-65	12.0	9.8	9.7	a13.9	14.2	15.0
65-70	10.7	8.5	7.5	12.7	14.0	11.1
70-77	9.2	7.9	7.2	9.9	b9.9	b11.2
60-77	10.4	8.7	8.0	c11.3	d12.5	d12.3

a: 61-65 b: 70-76 c: 61-77 d: 60-76

Table I.6

LABOR FORCE GROWTH RATES (NON-AGRICULTURE)

Period	The Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
60-65	7.2	4.4	4.7	a6.7	6.7	6.9
65-70	5.4	2.6	2.2	5.0	6.5	4.7
70-77	2.5	1.2	1.3	4.1	b3.3	b4.1
60-77	4.7	2.5	2.6	c5.0	d5.3	d5.2

a: 61-65 b: 70-76 c: 61-77 d: 60-76

In order to fit this model, a substantial data set was accumulated. A description of this data set and its properties and a tabular listing of significant portions of it are in Appendix A. To my knowledge, this is the first time parts of this set have been assembled in consistent, time-series form.

The principal topics of enquiry of this dissertation can be divided into two groups: questions related to comparing and contrasting the proximate causes of growth in the Baltic and Central Asia; and questions related to evaluating the regional impact of Soviet economic policy. Naturally, this is a simplistic classification basis, since different regional growth relationships and prospects influence government economic policy, including its regional aspects. And government economic policies have influenced the causes of growth disparately in different regions.

Regarding differences in the causes of regional growth, the central issue is to account for differences in the relationship between the level and growth of primary factor inputs (land, labor, and capital) and the level and growth of NMP. Of particular interest are differences in the growth of factor productivity, and differences in scale economies.[12] In particular, a map showing the Soviet rail system suggests that the Baltic has far better transportation connections, both intraregionally and interregionally, than Central Asia (see Map 4). Studies of regional freight shipment destinations show substantially different economic ties for the Baltic than for Central Asia. The Baltic is a recipient of raw materials and a shipper of finished products, while the reverse is true of Central Asia.[13] Accordingly, the growth of opportunities

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[12]Economies of scale a priori can be expected to be an advantage for the Baltic, where firms are smaller than the Soviet average, but with, generally speaking, higher-than-the-average Soviet output per unit of primary input. Apparently, the Baltic has escaped at least partially the Soviet tendency toward concentration of production in very large scale plants. See Woroniak, "Regional Aspects," p. 277; A. B. Margolin, ed., Pribaltiiskii Ekonomicheskii Raion (The Baltic Economic Region) (Moscow: Nauka, 1970), pp. 17-18, and Per O. Stangert. "Economies of Scale in Soviet Industry: Intertemporal, Regional, and Branch Analysis," in Vladimir G. Treml (ed.), Studies in Soviet Input-Output Analysis (New York: Praeger, 1977), p. 113.

[13]V. S. Varlamov, "Geographical Features of Interregional Ties Between the Territorial-Production Complexes of the Western and Eastern Regions of the USSR," in Demko and Fuchs, Geographic Perspectives, pp. 171-176. The results of other analyses suggest that the Baltic may also receive a cost advantage due to practices in setting Soviet freight tariffs; see Vsevolod Holubnychy, "Spatial Efficiency in the Soviet Economy," in Bandera and Melnyk, The Soviet Economy, p. 28, and Idem, "Some Economic

for interregional specialization will be considered explicitly as an element conditioning joint factor productivity growth of the primary factors.

In addition to the relationship between factor and output growth, the model endogenously accounts for changes in labor and capital in the two regions. The land area under cultivation is taken as exogenous although there was expansion of Central Asian crop area during the study period due to land reclaimation.

The model endogenously provides for intra-regional rural to urban migration, and for labor force participation, based on the pool of potential workers, population growth rates (a proxy for the dependency burden) and wages (including only wages in the socialized sector of agriculture). Two very interesting questions concern the higher labor force participation rates in the Baltic, and the seeming reluctance of the surplus Central Asian rural population to migrate, either to Central Asian cities or to locations outside the region.[14]

Aspects," p. 64.

[14]The Central Asian rural population, viewed by many writers both in the Soviet Union and elsewhere as surplus in its current agricultural employment, is discussed in terms of its potential for employment in other locales in two excellent papers. See Murray Feshbach, "Prospects for Outmigration from Central Asia and Kazakhstan in the Next Decade," in Joint Economic Committee, 96th Congress, 1st Session, Soviet Economy in a Time of Change, (Washington, D. C.: Government Printing Office, 1979), vol. 1, pp. 656-709, and S. Enders Wimbush and Dmitry Ponomareff, Alternatives for Mobilizing Soviet Central Asian Labor: Outmigration and Regional Development (Santa Monica: The Rand Corporation, R-2476-AF, 1979), pp. 1-38.

Investment and capital formation make up a logical block of the model. One important line of inquiry related to differences in the sources of growth examines the hypothesis that there are substantial differences in the investment cost of forming a given amount of capital in Central Asia, compared to the investment cost of forming the same amount of capital in the Baltic.[15] Soviet accounting practices count as investment the allocation of material product to accumulation, for the purpose of augmenting or replacing basic funds (fixed capital assets). The capital stock is determined from the book value of assets of enterprises.[16] Differences between total investment and gross capital formation are due to losses during the process of capital formation. Such losses could be due to waste of materials, project cancellations (or changes leading to losses), high wage costs due to inefficient labor, etc.

The relationship between Soviet economic policy and regional development can itself be viewed as comprised of two elements. First, there are those elements of Soviet policy that are directed specifically toward regional issues. Second, there are those elements of economic policy directed toward goals that are not regional in nature (for example, pursuit of growth or defense objectives) but which

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[15]See, e. g., Ann Sheehy, "Some Aspects of Regional Development in Soviet Central Asia," Slavic Review 31 (September, 1972), p. 558.

[16]Raymond P. Powell, "The Soviet Capital Stock from Census to Census, 1960-1973," Soviet Studies 31 (January 1979), p. 66.

have important consequences for regional growth differences.

The model developed below is designed to investigate two aspects of regionally-directed policy: the direction of investment to reduce regional economic inequality (measured by differences in regional levels of per capita NMP) by enhancing the growth of poorer regions; and the allocation of resources to reduce inequality in per capita consumption. Two blocks of the model, wage determination and consumption, are primarily intended to evaluate the regional aspects of Soviet consumption and consumption-related issues, although, as we shall see, information about wage policy is useful in other areas of conjecture. The proposition that investment resources are allocated so as to favor poorer regions is tested specifically by means of the investment equations.

The investment equations are also mechanisms for evaluating the relationship between the sector and industrial branch composition of Soviet national investment, and total regional investment, based on regional composition of capital. Likewise, the regional significance of defense spending is evaluated via the investment equations. Other basically non-regional aspects of the Soviet economy that are, at least potentially, of regional significance include a pattern of investment crisis-response to harvest conditions and the regional influence of the five-year planning cycle, which could influence regions differently due to differences in composition of output.

Finally, considering the model's results as a whole

leads to conjecture regarding reasons why regional inequality not only persists in the Soviet Union in spite of at least some political priority on reducing inequality, but indeed over the greater part of this study period perhaps even increased, depending on how regional units are chosen.[17] One important conclusion is that, as with market economies,[18] developed areas offer greater returns on investment, and therefore planners tend to locate more investment there. It will be argued that the Soviet policy of keeping wage rates at remarkably similar levels across different regions could exacerbate the planners' preferences for locating new projects in developed European regions (such as the Baltic) compared to poorer non-European regions (such as Central Asia), because productivity differences more than offset the small wage differences.

This dissertation is divided into five chapters and three appendices. An econometric model for the analysis of Soviet regional economic growth is developed in Chapter II, which consists of two sections. The first section contains a discussion of the objectives of the econometric model. In the second section, the model is presented in its entirety, and its rationale elaborated in detail.

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[17]James W. Gillula, "The Economic Interdependence of Soviet Republics," in Joint Economic Committee, Soviet Economy in a Time of Change, vol. 1, p. 653.

[18]See, e. g., Simon Kuznets, "Economic Growth and Inequality," American Economic Review 45 (March, 1955), pp. 1-28, and the Paukert and Williamson articles cited in footnote 1 above.

Chapter III also consists of two sections. The first is a discussion of the method used in fitting the model. The second section of Chapter III contains the results of estimating equations describing the key relationships in this study: output; investment; and consumption. These equations provide the essential information to describe the production process in the two regions, and to evaluate selected issues regarding Soviet economic policy and its regional influence.

Chapter IV is made up of a single section, containing the estimation results for the remaining equations in the model. These concern rural-urban migration, the labor supply, wage determination, and capital formation.

Chapter V also consists of two sections. First, the results of estimating the model for the Baltic and Central Asian regions are summarized, with special regard for the principal questions of the study: differences in regional growth relationships; effective Soviet regional policies; and the regional importance of non-regional economic policies. Second, recommendations are made for further research, based on the findings in this study.

Appendix A is a discussion of the data covering sources, theoretic content of variables in the model, quality, and the process used to estimate some data entries. Appendix B contains a more detailed discussion of two econometric issues than would conveniently fit into the text of Chapter III without major digression. These issues are

the properties of instrumental variables estimation procedures in a simultaneous equation system containing errors-in-variables and parameter identification in such a system. Appendix C discusses the method used to construct an index of regional agglomerative potential, and some theoretic properties of that index.

CHAPTER II

AN ECONOMETRIC MODEL TO ANALYZE SOVIET REGIONAL ECONOMIC GROWTH

Basic Objectives of the Model

This model meets two basic objectives. The first is to analyze economic growth in the Baltic and Central Asia. The second, perhaps of more general interest, is to evaluate the relationship between Soviet economic policy and regional economic growth. Under the second heading come two aspects of economic policy. First, some activities are not specifically addressed to regional issues, but nonetheless are important for regional growth differences since they influence regions disparately. Examples of this are defense policy, and priority expansion of some sector or branch of the economy. Second, some economic policies are directed specifically toward regional issues. Examples of these are transfers of resources from prosperous regions to poor ones to subsidize consumption, or the allocation of investment resources into poorer regions specifically for the purpose of expanding their economies.

This analysis of regional economic growth begins with the relationship between primary factor inputs (land, labor, and capital) and output, and the changes in factor productivity generated by non-economic variables (for example, the weather in agriculture). Endogenous to the model are changes in the factors of production, due both to causes that are internal to the region and to actions of the Soviet central authorities. Finally, the relationships between wages and the average product of labor, and output and consumption (both total and private) are endogenous.

Evaluating the relationship between Soviet government economic decisions and economic development in the Baltic and Central Asia is a principal objective of this study. Specifically, the Soviet *government*, via the vehicles of profit taxes and the turnover tax, and either the state budget, or investment policy, or both, can transfer resources from richer to poorer regions.[1] One of the issues here is to determine if level of development related resource transfers have been for the objective of consumption or investment.[2] Government policies

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[1]Ivan S. Koropeckyj, "Methodological Problems of Calculating National Income for Soviet Republics," Journal of Regional Science 12 (December, 1972), p. 378. See also Appendix A for a discussion of the turnover tax and the calculation of republic net material product.

[2]James W. Gillula, "The Economic Interdependence of Soviet Republics," in Joint Economic Committee, 96th Congress, 2nd Session, Soviet Economy in a Time of Change (Washington, D. C.: Government Printing Office, 1979), vol. 1, pp. 630-636, has already shown the existence of such transfers, plotted their size over time for a few republics for which data are available, and offered some educated

influencing investment in different economic regions could be for the purpose of equalizing levels of development, [3] or for the pursuit of general economic goals such that, while they are not directed at issues of regional development, they nonetheless have regional significance. Particularly important in this latter category is the pursuit of defense policy objectives.

Government action can also affect regional consumption. The data on consumption (both total and private) contain fewer observations than for the other variables in the model, but there are enough for statistical inference, particularly since the consumption variables do not appear anywhere as explanatory variables (see Appendix A). The specific objective in estimating the consumption equations is to determine if the relative level of regional economic development contributes anything toward explaining consumption, once NMP has been taken into account.

There are also certain operating characteristics of the Soviet economy that have been noted in previous works and that will be incorporated into this model. The most

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speculation on the probable uses of the transfers. One objective of the modeling approach used here is to improve understanding of the use of such transfers (which do not explicitly enter the model).

[3]Vsevolod Holubnychy, "Teleology of the Macroregions in the Soviet Union's Long Range Plans, 1920-90," in Andrew F. Burghardt, ed., Development Regions in the Soviet Union, Eastern Europe, and Canada. (New York: Praeger, 1975) p.101, and Idem, "Spatial Efficiencies in the Soviet Economy," in V. N. Bandera and Z. L. Melnyk, eds., The Soviet Economy in Regional Perspective. (New York: Praeger, 1973), p. 25.

important of these for this inquiry is the "priority" nature of the Soviet economy. In the absence of scarcity prices, the fundamental decisions (according to this line of reasoning) are made on the basis of planners' priorities. These decisions have economic relevance in two fashions. First, priority sectors receive favorable treatment in the allocation of investment resources among competing claimants. Second, the authorities may intervene in the day-to-day operation of the economy to insure that priority activities actually receive planned input supplies, etc. Note that plans must be taut (difficult to fulfill) for this second aspect of the priority economy to be important.[4] The second operating characteristic is the plan cycle, which is a cycle of investment and capital formation based on the five year planning period. The essential elements of the plan cycle are that project initiations (and investment) tend to cluster in the early years of a five year plan, and project completions to cluster in the later years. The early concentration of investment is both because of the requirement to lay the foundations in producer-goods to execute later programs, and because managers tend to initiate projects early in the period to establish claims on

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[4]Z. M. Fallenbuchl, "How Does the Soviet Economy Operate Without a Free Market?" in Morris Bornstein and Daniel R. Fusfeld, eds., The Soviet Economy: A Book of Readings, 4th ed. (Homewood: Irwin, 1974), pp. 7-9 and Herbert S. Levine, "Pressure and Planning in the Soviet Economy," also in Bornstein and Fusfeld, pp. 47-53.

resources.[8]

In addition, the model considers the relationship between agglomerative potential and growth of output. This line of inquiry takes into account the size and location of cities in the Soviet Union as influences on the growth of joint factor productivity. By location is meant not only the point on the earth's surface occupied by a given city (its absolute location), but also its integration into the rail net (its relative location).

One last word regarding the general modeling approach used here has to do with deciding which variables to make endogenous and which to treat as exogenous. As always, there was a certain amount of arbitrariness in the final decision; indeed, in two or three instances it was determined by availability of data. The general strategy is to treat as endogenous those variables which are region-specific (for example, the wage rate, even though it is highly related to national wage policy) and variables which are primary inputs into the regional productive process, (for example, investment) since they are vehicles for analysis of the regional importance of government decisions. Variables that are Soviet economy totals are exogenous (i.e., sector investment and sector capital stocks).

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[8]Richard S. Eckhaus and Kerit S. Parikh, Planning for Growth (Cambridge: M.I.T. Press, 1968), pp. 14, 27-28 discuss theoretical aspects of planning cycles, and Donald W. Green and Christopher I. Higgins, SOVMOD I: A Macroeconomic Model of the Soviet Union (New York: Academic Press, 1977), pp. 123-124, 271 implement it using the dummy variable approach.

The Model and its Rationale

There are 22 equations in 5 structural blocks in the basic model. These are listed first for convenience, followed by their rationale.

Output.

$$(1) \qquad \ln Q_t = \alpha_0 + r^{\cdot}T50_t + \alpha_1 \ln K_t + \alpha_2 \ln L_t + \varepsilon_{Q,t}$$

$$(1.1) \qquad q_t = r_t + \alpha_1 k_t + \alpha_2 l_t + \varepsilon_{q,t}$$

$$(1.1a) \qquad r_t = \beta_0 + \beta_1 qa_t$$

$$(1.1b) \qquad r_t = \beta_0 + \beta_1 qa_t + \beta_2 a_t$$

$$(1.1c) \qquad r_t = \beta_0 + \beta_1 qa_t + \beta_2 knp_t + \beta_3 gkf_{t-1} + \beta_4 ls_t$$

$$(2) \qquad \ln QA_t = \gamma_0 + ra^{\cdot}T50_t + \gamma_3 \ln KA_t + \gamma_4 \ln LA_t + \gamma_5 \ln TR_t + \varepsilon_{QA,t}$$

$$(2.1) \qquad qa_t = ra_t + \gamma_1 RAINDIF_t + \gamma_2 TEMPDIF_t + \gamma_3 ka_t + \gamma_4 la_t + \gamma_5 tr_t + \varepsilon_{qa,t}$$

$$(2.1a) \qquad ra_t = \delta_0 + \delta_1 fert\%_t + \delta_2 irri\%_t$$

$$(3) \qquad Q_t = (1+q_t)\cdot Q_{t-1}$$

$$(4) \qquad QA_t = (1+qa_t)\cdot QA_{t-1}$$

$$(5) \qquad NMP_t = Q_t + QA_t$$

Inputs into the Productive Process.

$$(6) \qquad POP_t = POPU_t + POPR_t$$

$$(7) \qquad [\Delta POPU_t - (PGR_{t-1}/1000)\cdot POPU_{t-1}] = \zeta_0 + \zeta_1 POPR_{t-1} + \zeta_2 POPR_{t-1}\cdot T50_{t-1} + \zeta_3 (W_{t-1}-WA_{t-1})/W_{t-1} + \zeta_4 \Delta HU_t + \zeta_5 AGCYCR_{t-1} + \zeta_6 M_{t-1} + \varepsilon_{PU,t}$$

$$(8) \qquad POPU_t = POPU_{t-1} + \Delta POPU_t$$

$$(9) \qquad L_t = \eta_0 + \eta_1 POPU_t + \eta_2 POPU_t\cdot T50_t + \eta_3 W_t + \eta_4 PGR_t + \varepsilon_{L,t}$$

$$(10) \qquad (1+l_t) = L_t/L_{t-1}$$

$$(11) \qquad LA_t = \theta_0 + \theta_1 POPR_t + \theta_2 POPR_t\cdot T50_t + \theta_3 WA_t + \theta_4 PGR_t + \varepsilon_{LA,t}$$

$$(12) \qquad (1+la_t) = LA_t/LA_{t-1}$$

Investment and Capital Formation.

$$(13) \quad I_t = \lambda_0 + \lambda_1 PRIO_t + \lambda_2 RDEV_t + \lambda_3 DF_t + \lambda_4 FYPCA_t + \varepsilon_{I,t}$$

$$(14) \quad K_t - (1-wdl)\cdot K_{t-1} = \mu_1 I_{t-1} + \mu_2 I_{t-2} + \mu_3 I_{t-3} + \varepsilon_{K,t}$$

$$(15) \quad (1 + k_t) = K_t / K_{t-1}$$

$$(16) \quad IA_t = \xi_0 + \xi_1 PRIOAG_t + \xi_2 RDEV_t + \xi_3 DF_t + \xi_4 FYPCA_t + \xi_5 AGCYCR_t + \xi_6 AGCYCR_{t-1} + \xi_{IA,t}$$

$$(17) \quad KA_t - (1-wdlag)\cdot KA_{t-1} = \pi_1 (IA_{t-1} + IA_{t-2})/2 + \varepsilon_{KA,t}$$

$$(18) \quad (1 + ka_t) = KA_t / KA_{t-1}$$

Wages.

$$(19) \quad W_t = \tau_0 + \tau_1 D6877_t + \tau_2 VMPL_t + \varepsilon_{W,t}$$

$$(20) \quad WA_t = \phi_0 + \phi_1 D5865_t + \phi_2 APLACR_t + \varepsilon_{WA,t}$$

Consumption.

$$(21) \quad C_t = \psi_0 + \psi_1 NMP_t + \psi_2 RDEV_t + \varepsilon_{C,t}$$

$$(22) \qquad CPVT_t = \omega_0 + \omega_1 NMP_t + \omega_2 RDEV_t + \varepsilon_{CPVT,t}$$

A key to the variables symbols is in Table II.1, and an expanded coverage of their definitions is in Appendix A. Table II.1 lists only the annual levels of variables. The notation used throughout this dissertation is that lower case letters used as variable symbols refer to rates of growth, and upper case letters refer to levels. Agriculture sector variables can be distinguished from similar non-agriculture sector variables by a suffixed A; for example, K is the non-agricultural capital stock and KA the agricultural capital stock. Six of the variables, PRIO, PRIOAG, AGCYC, RDEV, RAINDIF, and TEMPDIF, are constructed. The particular method and rationale for their construction are discussed at greater length below.

The output equations (equations [1] and [2]) and the derived growth equations are of the Cobb-Douglas general type, but without any restrictions imposed on the returns to scale. Equation (1) is based on the assumption of a constant rate of growth of joint factor productivity (r) and two primary factor inputs, capital and labor. This can be written as

$$Q_t = S \cdot \exp(r \cdot T50_t) \cdot K_t^{\alpha 1} L_t^{\alpha 2}$$

where S is a scale parameter. Taking the logarithms of both

TABLE II.1

VARIABLE SYMBOLS USED IN THE BASIC MODEL

Symbol	Variable	Brief Description
A	Agglomerative Potential	Measures the potential for economies of agglomeration based on a gravity model of potential. The arguements in its construction (a multistage process described below and in Appendix C) are city population, graph-theoretically determined measures of rail net connectivity, and absolute city location.
APLACR	Average Product of Labor in Agriculture (Current Rubles)	Calculated
AGCYC	Agriculture Cycle	Measures the difference between "expected" agricultural output and actual output. It is the residual from a regression of QA against a second order polynomial on time.
C	Consumption (Ispol'zovanie natsional'nogo dokhoda na potreblenie)	Measures total consumption, which in Soviet parlance includes items of communal consumption classified as government expenditures in the West.
CPVT	Private Consumption	Measures consumption expenditures of private households.
DF	Defense Expenditures	An estimate of total defense outlays in millions of 1970 rubles.
FERT%	Amount of Fertlizer per Hectare of Sown Area	Calculated by dividing total fertilizer deliveries to agriculture by the total sown area. See TR below.

TABLE II.1 (Continued)

Symbol	Variable	Brief Description
FYPCA	Five Year Plan Cycle, Early Portion	A dummy variable with a value of one during the first two years of a five year plan, and a zero otherwise.
GKF	Capital Stock Put into Active Use (vvod v deistvie)	Measures the 1955 ruble value of capital stock in all spheres, placed into use during the calendar year.
HU	Urban Housing (gorodskoi zhi-lishchnyi fond)	Total area of usable dwelling space in urban settlements.
I	Investment (Non-agricultural) (kapital'nye vlozheniia)	Capital investment by state and cooperative enterprises (excluding kolkhozes) in non-agricultural material production.
IA	Investment (Agricultural)	Capital investment by the state and kolkhozes in agriculture.
IRRI%	Irrigated land as a Portion of Sown Area	Calculated by dividing the total utilized irrigated area (ispol'zovanie oroshaem-ykh sel'skokhoziaistvennykh ugodii) by total sown area.
K	Capital Stock in the Productive Sphere(Non-agri-cultural) (osnovnye fondy)	Value in millions of 1955 rubles of all fixed assets in use on 1 January.
KA	Capital Stock in Agriculture	Value in millions of 1955 rubles of fixed assets in use on 1 January in agricul-ture (including the productive herd and certain long-term plantings).

TABLE II.1 (Continued)

Symbol	Variable	Brief Description
KNP	Capital Stock in the Non-productive Sphere	Value in millions of 1955 ruble of fixed assets in use on 1 January in the non-productive sphere (services, including health, housing, and educational plant, etc.)
L	Labor Force in the Non-agricultural Productive Sphere	Unit of account is number of average annual workers, in thousands.
LA	Labor Force in Agriculture	Unit of account is number of average annual workers (social sector), in thousands.
LS	Skilled Workers in all Employment	Includes all workers with higher or middle specialized education.
M	Net Regional Immigration	Measured as the difference between total population change and natural increase (thousands of people).
NMP	Net Material Product (natsional'nyi dokhod)	Measured in millions of 1965 rubles. Calculated as the sum of NMP created in the five major sectors, or Q + QA. See Appendix A.
PGR	Natural Population Growth	Measured per 1000 inhabitants.
POP	Total Population	Thousands of people.
POPR	Rural Population	Thousands of people living on farms and in smaller (fewer than 10 to 15 thousand inhabitants) towns.

TABLE II.1 (Continued)

Symbol	Variable	Brief Description
POPU	Urban Population	Thousands of people living in larger (more than 10 to 15 thousand inhabitants) cities.
PRIO	Regional Investment Priority	See text.
PRIOAG	Regional Investment Priority (Agriculture)	See text.
Q	NMP Created in the Non-agricultural Sectors of the Material Sphere	Measured in millions of 1965 rubles, and based on official growth indexes by sector when available or else on estimated deflators and current ruble values.
QA	NMP Created in Agriculture	Same as Q, except covers the agriculture sector.
r	Growth of Joint Factor Productivity, Non-Agriculture	See text.
ra	Growth of Joint Factor Productivity, Agriculture	See text.
RAINDIF	Relative Rainfall Index	See text.
RDEV	Regional Population-weighted Index of Per Capita NMP	See text.
TEMPDIF	Relative Temperature Index	See text.
T50	Time Index 1950=1	

TABLE II.1 (Continued)

Symbol	Variable	Brief Description
TR	Total Sown Area in Agriculture	Measured in thousands of hectares.
VMPL	Value of the Marginal Product of Labor	Calculated from the results of eq. (1) and Q and L.
W	Average Monthly Wage, Non-agriculture	Measured in current year rubles. Considerable estimation for 1961-1964.
WA	Average Monthly Wage, Agriculture (Social Sector) Sector)	See W above.
wdl	Physical Rate of Capital Withdrawal, Non-agriculture	Computed as the weighted average of the withdrawal rates calculated by sector for SOVMOD I.
wdlag	Physical Rate of Capital Withdrawal, Agriculture	Based on values determined for SOVMOD I.

sides, writing ln S as as α_0, and adding a stochastic specification gives

$$(1) \qquad \ln Q_t = \alpha_0 + r \cdot T50_t + \alpha_1 \ln K_t + \alpha_2 \ln L_t + \varepsilon_{Q,t}.$$

The related growth equation is derived by substituting an expression allowing for period-specific changes in joint factor productivity, expressed in discrete time:

$$Q_t = \prod_{j=1}^{t}(1+r_j) S \cdot K_t^{\alpha_1} L_t^{\alpha_2} \varepsilon^*_{Q,t}.$$

Dividing the expression for period t by the expression for period t-1 gives (after some simplification)

$$(Q_t/Q_{t-1}) = (1+r_t)(K_t/K_{t-1})^{\alpha_1}(L_t/L_{t-1})^{\alpha_2} \cdot(\varepsilon^*_{Q,t}/\varepsilon^*_{Q,t-1})$$

Taking the natural logarithm of both sides of equation (1.1) gives

$$\ln Q_t - \ln Q_{t-1} = r_t + \alpha_1(\ln K_t - \ln K_{t-1}) + \alpha_2(\ln L_t - \ln L_{t-1}) + (\varepsilon_{Q,t} - \varepsilon_{Q,t-1})$$

or

$$(1.1) \qquad q_t = r_t + \alpha_1 k_t + \alpha_2 l_t + \varepsilon_{q,t}.$$

Equation (1.1) is derived by taking advantage of the fact that, e.g., if r_t lies close to zero (i.e., if $-.1<r_t<.1$) then $\ln(1+r_t) \simeq r_t$. For the range of values involved, this is quite a close approximation.

The variable parameter r_t is stylistically interpreted here as the rate of joint factor productivity growth. Three alternate versions of equation (1.1a) are suggested. All three forms have r_t as a function of agricultural growth; an alternative format in each case would be to substitute qa_{t-1} for qa_t. There are two basic reasons for believing the growth rate of agriculture to be important in the

determination of non-agricultural growth. First, when agriculture does well, stores and collective farm markets will be relatively well stocked. Consequently, shoppers will be able to acquire the goods (especially foodstuffs) they seek more quickly and with less effort (searching, standing in line, etc.). Less time spent shopping implies more time for other pursuits, including more time on the job (the average annual worker unit of account won't capture small deviations in the average hours worked per employee).[4]

Second, agricultural products are inputs into both the food and light industries. Generally, in both the Baltic and in Central Asia the capital stock in each of these two industries makes up a larger share of total industrial capital stock than it does for the USSR as a whole.[5] Therefore, the growth rate of output in agriculture is related to the growth rate of raw material inputs into the manufacturing process.[6] This argument does make the

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[4]Gregory Grossman, "Notes on the Illegal Private Economy and Corruption," in Joint Economic Committee, 96th Congress, 1st Session, Soviet Economy in a Time of Change, vol. 1, p. 836, notes that the "theft" of "company time" is a frequent occurence.

[5]For the years 1962 through 1975, except for 1967, the industrial branch composition of fixed assets is published by republic in the Soviet national statistical handbook, Narodnoe Khoziastvo SSSR v **** godu (The National Economy in the **** year). Data for the missing years is sometimes available in the handbooks for the individual republics; see Table A.1.

[6]For a work including material inputs as a factor of production, see Padma Desai, "The Production Function and Technical Change in Postwar Soviet Industry: A

interpretation of the role of qa_t or qa_{t-1} in equation (1) ambiguous, since it can be viewed as a proxy variable for material inputs and therefore a third factor of production.[9] The view taken here is that the primary factors in the relationship are capital and labor, and other variables entered into the equation serve to determine the productivity of the primary factors.

Equation (1.1b) has r_t as a function of both qa_t and a_t, where a_t is the growth of regional agglomerative potential. This is based on a model of regional economic growth proposed by Harry W. Richardson. According to Richardson, a definition of agglomeration economies would have to cover external economies of scale, indivisibilities, and urbanization economies. In general, agglomerative potential is the potential for economies that are external to individual firms and are associated with the growth of large urban-industrial concentrations.[10]

There are two sets of components to an index of agglomerative potential: distance (or frictive) elements; and agglomerative elements.[11] The functional form of a

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Reexamination," American Economic Review 66 (June 1976) pp. 379-381.

[9]Of course, in growth equations derived from the Cobb-Douglas family, functional form does not help distinguish between primary factors and factors included because they are thought to contribute to Hicks-neutral productivity growth.

[10]Richardson, Harry W. Regional Growth Theory. (London: Macmillan,1973), pp. 28-29, 175-179.

[11] Richardson, Harry W. "Agglomerative Potential: A

useful index of agglomerative potential, A_t, should have the property that $\partial A_t/\partial AGG_{j,t}>0$ and $\partial A_t/\partial D_{i,t}<0$, where $AGG_{j,t}$ is the jth of J sources of agglomeration, and $D_{i,t}$ is the ith of I frictive elements; I does not necessarily equal J. The values of A_t calculated for use here have a single agglomerative argument: city population. Cities with more than 200,000 inhabitants (100,000 in the Baltic and Central Asia) on 1 January 1977 have been included in the calculation. There are two arguments to the distance or frictive element: the absolute location of cities and regions (and therefore the straight-line distance separating them); and the accessibility of each city or region. Accessibility is measured by graph-theoretically determined connectivity indexes.

The variable A_t here is interregionally generated agglomerative potential. A measure for this is calculated in two stages. First, an intra-regional measure of "effective urban center of mass" (EUC) is calculated based on city populations, absolute locations, and transportation (rail) net connectivity. Second, A_t is calculated for the Baltic and Central Asia based on regional EUCs (exhaustive across the USSR), and their absolute and relative locations. More precise and detailed discussion of the calculation of A_t is in Appendix C.

As noted in Chapter I, there are some draw-backs to the

Generalization of the Income Potential Concept," Journal of Regional Science 14 (December, 1974), pp. 331-333.

use of Soviet regional definitions. In some cases, economically cohesive regions have been split due to political, administrative, and/or ethnic considerations. An example of this of particular importance for this study is the assignment of Alma-Ata and other cities of southern Kazakhstan to the Kazakh economic region, although they are economically a part of Central Asia.[12]

The basic notion behind the inclusion of a_t in the expression for productivity growth is that the larger Soviet cities are characterized by greater factor productivity than are smaller settlements.[13] The closer are cities in a region to one another, both in terms of absolute distance and in terms of rail accessibility, and the closer together are regions, in the same terms, the greater is the potential for economies arising out of interaction and specialization. This might be because, as in market economies, management tends to be better than it is in smaller cities, and because larger cities are the sites of larger pools of special skills, not always present in smaller towns. Further, the more densely are firms located (as in a large city) the more quickly would one expect innovation to spread among enterprises. Finally, opportunities for specialization are greater, the larger the urban concentration.

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[12]See David Hooson, "The Outlook for Regional Development in the Soviet Union," Slavic Review 31 (September, 1972), p. 536.

[13]Capital seems to be more productive in large than in small cities in the USSR. See Vsevolod Holubnychy, "Spatial Efficiency in the Soviet Economy," in Bandera and Melnyk,

There are also reasons to expect that the form of agglomerative economies is at least in part different in the Soviet economy than is the case in Western countries. First, there is the role of the party in smoothing out unforeseen difficulties in the plan. Obviously, the more firms are located within the territorial bounds of local party responsibility, the greater will be the opportunity for party action (assuming party intervention at this level to enhance the net value of output). Second, and perhaps more important, is the action of the informal economy. The more densely are firms situated, the easier it would be for "blat" (a sort of reciprocal favoritism and influence) to operate, and the easier it would be for expediters to operate (principally to locate and obtain critical input supplies).[14]

The more large cities in a region, and the closer they are to one another, then the greater are the opportunities for similar economies among these cities. Also, the better integrated is a city in the regional rail net, the better situated it is to benefit from inter-urban interaction.[15]

The Soviet Economy, p. 29.

[14]Other writers have speculated that under-urbanization may be a cause of labor shortage in some areas. See Fuchs, Roland J. and Demko, George J. "Geographic Inequality Under Socialism," Annals of the Association of American Geographers 69 (June 1979), p. 315.

[15]Eighty per cent of freight turn-over (measured in ton-kilometers) in 1960 and 59 per cent in 1977 moved by rail. The difference is due to the increased importance of pipeline and sea transportation. Source: Narkhoz 1977, p. 305.

However, over interregional distances agglomerative economies are undoubtedly operating less because of party intervention, at least at lower levels, than they are on the other factors discussed above. The basic argument is that a region located close to urban-industrial complexes outside the region, and well-situated in the national rail net, occupies a favorable location compared to regions that are not.

For the Soviet Union during the study period, it is reasonable to expect the value of $\partial q_t/\partial a_t$ to be negative for some (less developed) regions, and positive for other (developed) regions. The rationale is that during the process of development some regions will afford greater opportunities for growth than others. Aside from allocation of the primary factors (capital and labor here), the developed (and more productive, in the efficiency sense) regions are apt to receive more reliable and higher quality inputs of intermediate goods. The reason is that the planners, knowing developed regions to be economically more efficient, will tend to locate higher priority enterprises there, and will turn to those regions first when production must be increased in some good to relieve a bottleneck.

As urban and industrial concentrations in the developed regions grow faster, a_t for the less-developed regions will be large, due to the method of calculation. However, the faster the developed areas grow, the more they will draw high-quality resources (both human and material) away from

the less developed regions. These areas are also likely to be the sites of high-priority ventures and to be preferred in resource allocation over backward regions for that reason. Accordingly, a priori one might reasonably expect a negative coefficient on a_t for Central Asia, and a positive coefficient for the Baltic.

While the principal method of estimating this model is by means of pooled data, Appendix C makes it clear that evaluation of the effects of agglomerative potential requires the use of region-aggregated data. While this allows estimation (with certain limitations discussed below in Chapter III) of the parameters in equation (1.1b), the smaller number of observations (16 for the Baltic, 15 for Central Asia) virtually precludes estimation of a combination of equation (1.1b) and equation (1.1c).

In addition to the agricultural growth rate, equation (1.1c) includes the growth rate of the capital stock in the non-productive sphere (personal services, public transportation, health, education, and housing, with housing accounting for by far the largest share), the growth rate of capital completions in all spheres (including non-productive) lagged a period, and the growth of skilled labor (i.e., the number of educated workers).

Intuitively, a better educated work force could be expected to be more effective in industrial tasks, and in particular, it should assimilate new technology better. However, there may not be a close relationship between

growth of the educated work force and growth of productivity in the Soviet Union. Stephen Rapawy points out that educational attainment of the labor force is not regionally differentiated in the same manner as other labor force characteristics. In particular, some of the poorer regions (e.g., Transcaucasia) have better educated work forces than some of the more prosperous regions (e.g., Lithuania).[16] Accordingly, inclusion of ls_t in equation (1.1c) will test the proposition that improvement of work force education increases productivity.

During the early development of location criteria for investment, Soviet economists (and the political leadership) were of the opinion that only the effectiveness of investment in the productive sphere was relevant. This led to a conflict between the growth priority and non-productive sphere investment. However, there is a growing opinion that the effectiveness of material sphere investment is related to the stock of capital in the non-material sphere, particularly as it influences the size and quality of the locally available work force.[17] Equation (1.1c) includes the growth rate of non-productive sphere capital to evaluate its direct effect on factor productivity growth in the material sphere.

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[16]Stephen Rapawy, "Regional Employment Trends in the USSR: 1950 to 1975," Joint Economic Committee, Soviet Economy in a Time of Change, vol. 1, p. 603.

[17]T. Khachaturov, "Development of the Theory of Effectiveness of Capital Investment, "Problems of Economics 21 (May,1978), p. 98.

Finally, Stanley Cohn has observed that technological progress in the Soviet Union (as elsewhere) is often transmitted via new equipment. Further, in a maturing industrial economy, replacement investment is increasingly important for transferring technological advance.[18] Unfortunately, the published statistics do not allow us to distinguish replacement from new investment, let alone evaluate the nature of the equipment being installed. However, we can determine the total value of capital put into active use in a given year in all uses; presumably, the more capital put into use, the more potential for technological progress. Hence, gkf_{t-1} enters equation (1.1c).

The relationships in equations (1) and (1.1) were derived from a Cobb-Douglas type production function. A priori, there is no compelling reason to presume this to be the most appropriate functional form. Accordingly, two alternative versions of equation (1) are also considered: the constant elasticity of substitution (CES) form; and one variable elasticity of substitution (VES) form. The vehicle for testing for the appropriate functional form is the growth equations. For the CES function, in the form

$$Q_t = \gamma[\delta K_t^{-\rho} + (1-\delta)L_t^{-\rho}]^{-\nu/\rho}$$

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[18]Stanley H. Cohn, "Soviet Replacement Investment: A Rising Policy Imperative," in Joint Economic Committee, Soviet Economy in a time of Change, vol. 1, pp. 230-231.

estimation is something of a problem. The approach used here is to begin with J. Kmenta's second-order Taylor series approximation:[19]

$$\ln Q_t = \alpha_0' + \alpha_1' \ln K_t + \alpha_2' \ln L_t + \alpha_3' (\ln K_t - \ln L_t)^2$$

where $\alpha_0' = \ln\gamma$, $\alpha_1' = \nu\delta$, $\alpha_2' = \nu(1-\delta)$, and $\alpha_3' = -1/2\nu\rho\delta(1-\delta)$. Taking first differences, adding a term for Hicks-neutral productivity growth, collecting terms, and specifying the error term give

$$(1.2) \quad q_t = r_t + \alpha_1' k_t + \alpha_2' l_t + \alpha_3' [(\ln K_t - \ln L_t)^2 - (\ln K_{t-1} - \ln L_{t-1})^2] + \varepsilon_{q,t}'.$$

Vittorio Corbo[20] has shown that this approximation of the CES function is also the second order approximation to a VES function which he attributes to M. Bruno. Consequently, without additional information one cannot categorically argue that, by using equation (1a), he has fit the CES rather than a VES function. However, Kmenta's approximation is much cheaper in computer time than non-linear methods of

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[19]Jan Kmenta, "On Estimation of the CES Production Function," International Economic Review 8 (June 1967), pp. 180-189.

[20]Vittorio Corbo, "Second Order Approximations for Estimating Production Functions," Annals of Economic and Social Measurement 5 (Winter, 1976) pp. 66-68.

estimation, and it yields good results when the elasticity of substitution between capital and labor is close to one. Hence, it is a cheap vehicle to test the proposition that the production function is Cobb-Douglas against the alternative that it is CES.

C.A. Knox Lovell[21] develops a linearly homogenous VES function, which he attributes to C. Ferguson, with the property that capital deepening drives the elasticity of substitution away from unity. This production function can be written

$$Q_t = \prod_{j=1}^{t}(1+r_j)S \cdot K_t^{\alpha_1''} L_t^{(1-\alpha_1'')} \exp[\alpha_2''(K_t/L_t)].$$

If the error in the equation is multiplicative, then we can proceed as above in the derivation of equation (1) to arrive at

$$(1.3) \quad q_t = r_t + \alpha_1'' k_t + (1-\alpha_1'')l_t + \alpha_2''(K_t/L_t - K_{t-1}/L_{t-1}) + \varepsilon_{q,t}''.$$

Like the choice of Kmenta's approximation for the CES function, equation (1b) was selected partly because it is cheaply estimated in terms of computer resources, and

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[21]C. A. Knox Lovell, "Estimation and Prediction with CES and VES Production Functions," International Economic Review 14 (October, 1973), p. 679.

because it provides a convenient test against the Cobb-Douglas form. One drawback to equation (1b) is that its parent production function has, for any given parameter set and output level, an elasticity of substitution that is strictly monotonic in the capital to labor ratio. Unfortunately, more flexible versions of the VES present substantial estimating difficulties.[22]

Development of equations (2) and (2.1) proceeds along similar lines, and so only salient issues are discussed here. The first thing to note is the use of three primary inputs: capital; labor; and cultivated land area. Second, the substantial amount written on the importance of the weather for Soviet agriculture makes the inclusion of indexes to measure the relative amount of rainfall ($RAIN_t$) and the relative temperature ($TEMP_t$) during critical periods preceeding the harvest hardly controversial. However, available data did not allow computation of weather indexes with sufficient detail or with the appropriate aggregation of information. This point is discussed below at greater length.

Derivation of equation (2) comes from specifying a constant rate of joint factor productivity growth. The production function can be written

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[22]Lovell, "Estimation," footnote to page 679.

$$QA_t = S' \cdot \exp(ra \cdot T50_t)\exp(\gamma_1 RAIN_t) \cdot \exp(\gamma_2 TEMP_t) KA_t^{\gamma_3} LA_t^{\gamma_4} TR_t^{\gamma_5} \varepsilon^*_{QA,t}.$$

Taking the logarithm of both sides and writing ln S' as γ_0 gives

$$(2) \quad \ln QA_t = \gamma_0 + ra \cdot T50_t + \gamma_1 RAIN_t + \gamma_2 TEMP_t + \gamma_3 \ln KA_t + \gamma_4 \ln LA_t + \gamma_5 \ln TR_t + \varepsilon_{QA,t}.$$

Equation (2.1), the agricultural growth equation, is derived from equation (2) by substituting an expression allowing for period-specific joint factor productivity growth rates, written in discrete time:

$$QA_t = \prod_{j=1}^{t} (1+ra_j) S' \exp(\gamma_1 RAIN_t)\exp(\gamma_2 TEMP_t) \cdot KA_t^{\gamma_3} LA_t^{\gamma_4} TR_t^{\gamma_5} \varepsilon^*_{QA,t}.$$

Dividing this expression by the one for period t-1 and then taking logs gives the expression for qa_t. In that equation are the terms $\gamma_1(RAIN_t - RAIN_{t-1})$ and $\gamma_2(TEMP_t - TEMP_{t-1})$, which are simply written as $\gamma_1 RAINDIF_t$ and $\gamma_2 TEMPDIF_t$.[23]

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[23]More detailed information on the temperature and rainfall conditions would undoubtedly improve these indexes, both from a theoretic perspective and in terms of their performance in the model. Unfortunately, sufficiently detailed data to consider the perhaps more relevant day-to-day variations in soil moisture content and temperature are not available. In the process of estimating the equations, moving average values of precipitation covering periods longer than a year were tried, but with no success.

Equation (2.1a), an expression for productivity growth in agriculture, is expressed in terms of two arguments: the growth in fertilizer deliveries per hectare of sown area; and the growth of irrigated land as a percentage of sown area. The irrigation variable is relevant only for Central Asia, where the extention of irrigated area should act to reduce drought losses, as well as to improve productivity. While there was no irrigation to speak of in the Baltic during this period, drainage was quite an important land melioriation activity there.[24] Unfortunately, data on drained land area in use prior to 1965 have not been located, nor a reliable method found to estimate them. Consequently, drained land in use is omitted from the model.

Determination of labor inputs within the model logically begins with the division of population into its rural and urban components (equation [7]); it is assumed that L_t is drawn from $POPU_t$ and LA_t is drawn from $POPR_t$. This is perhaps better described as an equation to account for net urban immigration, since the left-hand side is the difference between total urban population change during a year and the natural increase in urban population during that year. It should be noted that data on the population growth rate are the republic average, which are likely different by a small amount from both the rural and the

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[24]For a description of marshy land conditions and the importance of drainage in the Baltic, see A. B. Margolin (ed.), Pribaltiiskii Ekonomicheskii Raion (The Baltic Economic Region) (Moscow: Nauka, 1970), pp. 210-211.

urban rates of natural increase. The approximation is probably better for most of the Baltic than for Central Asia, since the Baltic is more urbanized (and hence the city rates weigh heavier in the average) and because there is apt to be less difference between rural and urban rates than in Central Asia. Much of the Central Asian city population is Slavic, while the rural population is Turkic and Shi'ite Moslem, with much higher birth rates.[28]

An important factor in migration is the pool of rural residents from which the migrants must come. Over the period of this study, the relationship between rural population and rural-urban migration may have changed due to both social and demographic factors. Accordingly, $POPR_{t-1}$ is modeled using a time-variable parameter; therefore, the second and third terms of equation (7) can be interpreted as $\zeta_t POPR_{t-1}$ where $\zeta_t = \zeta_1 + \zeta_2 T50_{t-1}$.

Historically, one draw of urban areas has been the higher average wage rate paid there. This is included in equation (7) as the percentage (expressed as a decimal fraction) difference between urban (non-agricultural) and rural (agricultural) wages. One problem with this measure is that WA includes state sector wages only, and thus ignores money incomes from private plots (particularly significant in the Baltic) and the value of subsistence from the plots. The importance of this omission is demonstrated

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[28]F. Douglas Whitehouse, "Demographic Aspects of Regional Development in the USSR," in Bandera and Melnyk, The Soviet Economy, pp. 161-163.

elsewhere.[26] It will be partly offset with the inclusion of the agricultural cycle.

It has been noted that an important consideration influencing household job and migration decisions is housing availability.[27] Soviet urban housing is poor and crowded by the standards of other industrial countries. However, living conditions in general are better in cities than in rural areas, so that there is apt to be a pool of people waiting to move contingent on housing. The variable $AGCYC_{t-1}$ is included because it carries two sorts of information. First, it gives some idea of the relative difficulty of recent agricultural working conditions. Second, poor years in the socialized sector of agriculture (for which data are published) are likely highly correlated with poor years for the private plots (for which data are not published) and thus reflect both pecuniary and subsistence conditions in the private sector. Finally, inter-republic migration typically involves skilled people moving to specific jobs (and thus having prior housing arrangements).[28] These jobs are usually in urban areas--

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[26]Clark John Chandler, "The effects of the Private Sector on the Labor Behavior of Soviet Collective Farms" (Ph. D. dissertation, University of Michigan, 1978), Chapter IV.

[27]Henry W. Morton, "The Soviet Quest for Better Housing--An Impossible Dream?" Joint Economic Committee, Soviet Economy in a Time of Change, vol .1, p. 808.

[28]Brian Silver, "Levels of Sociocultural Development Among Soviet Nationalities: A Partial Test of the Equalization Hypothesis," American Political Science Review 68 (December, 1974), p. 1620.

hence the addition of the final term to the equation.

During the period of this study, a quasi-market prevailed for labor. That is, the state set the wage and other conditions, and workers and potential workers then responded.[29] Accordingly, equations (9) and (11) resemble similar entries for a market economy; in fact, fitting those equations amounts to estimating the labor supply curve.

The relationship between L_t and $POPU_t$ in equation (9) is written as a time variable parameter. The rationale is that over time the character of the population is changing in terms of such things as age, social attitudes, and education, which in turn influence labor participation rates. For example, cultural and nationalistic forces are sometimes cited as contributing to falling labor participation rates in Central Asia.[30] The rate of population growth is included as a partial measure of the dependency burden; the higher the rate of increase, the more adults are apt to stay out of the labor force for child care.

The rationale for equation (11) follows the same lines as that for equation (9). However, it is important to remember that earnings in the private sector are not taken

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[29]Paul R. Gregory and Robert C. Stuart, Soviet Economic Structure and Performance (New York: Harper and Row, 1974), pp. 193-214.

[30]S. Enders Wimbush and Dmitry Ponomareff, Alternatives for Mobilizing Soviet Central Asian Labor: Outmigration and Regional Development (Santa Monica: The RAND Corp., R-2476-AF, 1979), pp. 9-11.

into account in WA_t.[31]

The investment and capital formation block is crucial to the model, since it implements a behaviorally-oriented theory to account for the input of capital into the growth model, and it also serves as a vehicle for testing key hypotheses regarding Soviet policy toward regional development. The specific regional investment relationships in this model stem from the proposition that fundamental decisions effecting resource allocation in the Soviet economy are based on administrative priorities established by the political leadership.[32] There are two reasons for the importance of administrative priority in Soviet resource allocation. First, as in all economies, some activities conducted by the government are not readily susceptible to cost-benefit type analyses (for example, defense budgeting). Second, the administered price set is not an efficient guide to resource allocation, particularly across ministerial administrative divisions.

There are two dimensions to economic priority, as used here. First, there are priorities in the growth and composition of output. Historically, the top priorities of Soviet leadership have been to attain high rates of industrial growth, and to build and maintain a powerful

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[31]See Clark J. Chandler, "The Effects of the Private Sector," for research showing the substitutibility of work in the private plots and work in the social sector.

[32]Fallenbuchl, "How Does," pp. 7-9, and Levine, "Pressure," pp. 47-53.

military. Subordinate to these general priorities have been sectoral and branch priorities, based on considerations as to the best way to achieve the principal goals of growth and defense. Examples of major branch priorities are the electrification program during the NEP, the concentration on coal, steel, and machine building in the pre-World War II period, the emphasis on the chemical industry during the Khrushchev era, and the growing importance of the energy-producing industries. Branches of the economy may enjoy short-term priority status if they are bottlenecks to general growth, or for "political" reasons. An example of the latter is the increased emphasis on consumer goods in 1967-1969 following the wage reforms; then, in 1969, lagging growth rates led to reduced priority for consumer goods industries.[33]

It is important to note the administrative nature of priority. The regime will not in general act to maximize the growth rate of the ruble value of output, because output is not measured in scarcity prices; in fact, Soviet economists have advocated separate investment criteria based on sector and branch of the economy, and based on region. These recommendations are motivated at least in part by perceived shortcomings in the price set.[34]

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[33]Green and Higgins, SOVMOD I, pp. 135-139.

[34]Leslie Dienes, "Regional Variations of Capital and Labor Productivity in Soviet Industry," Journal of Regional Science 12 (December 1972), pp. 402-404, and T. Khachaturov, "Development," p. 93.

The implications of sector and branch priority for regional investment are obvious. Regional investment proceeds at least in part from the perceived potential for output increases in the priority sectors. The potential for increase comes from two sources: opportunities to enhance existing plants; and locational advantages for the establishment of new capacity. Aside from the establishment of entirely new activities in a region (e.g. beginning the exploitation of previously-untapped mineral reserves), the two are apt to be spatially highly correlated.

Further, inconsistencies that emerge in the course of executing the plan are resolved on a priority basis. For example, when some intermediate good is not available in sufficient quantity to meet all uses planned for it, deliveries will be met first for users producing high-priority goods, with low-priority users left to cope as best they can.[33]

There are some special implications of the defense priority. For the Soviet economy as a whole, non-personnel defense spending has a displacement effect on investment in all branches of industry (including the machine tools and metalworking branch, surprisingly enough).[34] Briefly, the reason for this is that with a finite capacity in the

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[33]Michael Ellman, Planning Problems in the USSR: The Contribution of Mathematical Economics to their Solutions 1960-1971 (Cambridge: Cambridge University Press, 1973), pp. 18-39.

[34]Green and Higgins, SOVMOD I, p. 135.

machine tool industry, increases in military hardware procurement limit the possibilities of producing equipment for investment or consumer durables or both. Even if in the long run military security goals are themselves one of the important motives for the growth priority, in the short run the two objectives conflict. However, the displacing effects of military expenditures may fall differently on different regions, based on differences in the composition of industry.

The second dimension of economic priority is spatial. To begin with, there are preferred locations for certain industries for military reasons. The deliberate removal of industry east of the Urals preceding and during World War II is well known. The practice of placing defense plants at interior (eastern Russia and Kazakhstan) sites appeared to continue into the sixties.[37] Accordingly, one would expect major defense procurements to have a substantial displacement effect on investment in exposed regions (like the Baltic and Central Asia), while in some regions of the RSFSR the total effect of defense outlay increases could even be investment-enhancing.

Another aspect of spatial investment priority has to do with development policy, one of the topics of inquiry in this research. It is stated above that the principal long-

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[37]Ivan S. Koropeckyj, "Industrial Location Policy in the USSR During the Postwar Period," Joint Economic Committee, 91st Congress, 2nd Session, Economic Performance and the Military Burden in the Soviet Union (Washington, D. C.: Government Printing Office, 1970), pp. 262-263.

term leadership objectives are industrial growth and military strength. However, the complete set of goals are very complex. An expanded list of the policy objectives to be considered in choosing investment locations, a list that has been stable over the past 50 years, would include reducing "differences in the levels of development of republics and economic regions."[38] Indeed, reduction of regional inequality of development (with the proviso that equal does not mean identical in form) has been a stated goal of the party since Lenin made it part of his program at the Tenth Party Congress (1921), though at the time Lenin's platform was largely aimed at gaining support for the Bolshevist government.[39] To the extent that commitment to the long-term elimination of development differences is genuinely an objective of the regime, one would expect a negative correlation between population weighted regional levels of per capita income and levels of regional investment, considerations in pursuit of other objectives of investment policy being equal.

In equation (13), two "artificial" variables, $PRIO_t$ and $RDEV_t$, quantify the regional effects of sector and branch priorities, and the reduction of development inequality priority, respectively. The decisions of the Soviet leadership regarding the allocation of resources between

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[38]V. Udovenko, "Changes in the Location of Productive Forces in the USSR," Problems of Economics 21 (July 1978), p. 59.

[39]Holubnychy, "Teleology of the Macroregions," p. 101.

consumption and accumulation, the size of the defense budget, and the division of resources allocated to investment among competing sectors and branches of the national economy are all exogenous to this model. The objective in equation (13) is to determine the spatial distribution of investment, given these decisions, and in particular to determine investment in the Baltic and in Central Asia.

The formula used in calculating $PRIO_t$ is

$$PRIO_t = \sum_{i=1}^{N} (KPS_{i,t}/KPSSU_{i,t}) \cdot IPSSU_{i,t}$$

where $KPS_{i,t}$ is the regional 1 January capital stock for period t in the ith "sector," $KPSSU_{i,t}$ Soviet total 1 January capital stock in the ith "sector," and $IPSSU_{i,t}$ is total Soviet investment in the ith "sector." There are N=13 different non-agricultural "sectors" used. These "sectors" include three major sectors of the Soviet economy as aggregates: transportation and communications; construction; and trade, procurement, technical supply, and "other productive activities." The industrial sector is disaggregated into ten component branches: electrical energy; fuels; ferrous metals; chemicals and petrochemicals; machine building and metal working; forestry, lumber, and cellulose-paper; construction materials; light; food; and a residual category including all other industrial activities, most notably non-ferrous metals.

The rationale behind the use of $PRIO_t$ is that it provides an effective measure of a region's investment priority, based on the region's sector and industrial branch composition of capital. The logic of the relationship is based on the fact that comparative advantage is not a transitory phenomenon. On the contrary, over time the operation of an industry in a region (the depletion of mineral deposits by the extractive industries excepted) reinforces the original locational decision because a work force trained to that particular activity is built up. Therefore, it is reasonable to expect that most investment funds allocated to a particular sector will be distributed as they have been in the past, at least in so far as output objectives are concerned. The regional share of the total national capital stock in that sector is a good predictor, therefore, of the regional current share of investment in that sector. Further, as comparative advantage slowly shifts, so will the ratios in $PRIO_t$, though with a lag.

The variable $RDEV_t$ is designed to provide an index to the funds a region could expect to receive as the result of a consistent national policy of moving resources to poorer regions for the purpose of reducing inequality in income. It is calculated by the formula

$$RDEV_t = (NMP_t/POP_t - NMPSU_t/POPSU_t)\cdot POP_t$$

where $NMPSU_t$ is the net material product created in the USSR as a whole, and $POPSU_t$ is the national population. This

index has the property that for poor regions it is negative, for rich regions it is positive, for regions with a large population it tends to be large in absolute value, and for regions with a small population it tends to be small in absolute value.

Equation (13) contains DF_t; as has already been noted, an inverse relationship between defense expenditures and investment has been demonstrated for the Soviet economy as a whole for all branches of industry (see footnote 33). The regional influence of defense on investment due to the sectoral composition of regional economic activity is already captured in the $PRIO_t$ index. Consequently, the effect of DF_t, independent of $PRIO_t$, can be viewed as a purely locational effect, due to the practice of placing plants producing military goods in the interior of the USSR.

The interpretation of $FYPCA_t$ in equation (13) is similar to that of DF_t. The plan cycle (see footnote 5) in investment for the USSR as a whole is carried in $PRIO_t$. Consequently, the interpretation of the independent effect of $FYPCA_t$ is the difference between the national planning cycle and the regional cycle. One a priori reason for expecting its effect to differ from zero is the sub-branch composition of output, particularly in machine tools and metalworking, since that branch of industry produces investment goods, consumer durables, and military hardware.

Non-agricultural capital formation is related in equation (14). The most desirable relationship describing

capital formation, following Soviet accounting practices, would involve two equations:••

$$(14a) \qquad VVOD_t = \mu'_1 I_t + \mu'_2 I_{t-1} + \mu'_3 I_{t-2} + \varepsilon_{V,t}$$

and

$$(14b) \qquad K_t - (1-wdl)\cdot K_{t-1} = VVOD_{t-1} + \mu''_1 KREP_{t-1} + \varepsilon_{K,t}.$$

Two new variables have been introduced in equations (14a) and (14b): $VVOD_t$, which is new capital put into operation in the non-agriculture sectors of the productive sphere; and $KREP_t$, which is the financial allocation for capital repairs in those sectors. The basic logic is that new capital is placed in operation some time after the investment to create that capital is made. The relationship between investment and capital activation is described by a distributed lag.

The capital stock on 1 January is then the surviving capital stock from the start of the previous year plus those projects completed and put into active use plus a gain due to the actual application of the capital repairs allowance. During the period of this study, amortization allowances for

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••This modeling approach is consistent with the Soviet accounting system. It follows A. Emel'ianov and F. Kushnirskii, "Dinamicheskaia model' razvitiia narodnogo khoziaistva respubliki" (A dynamic model of the development of the national economy of a republic), Planovoe khoziaistvo 47 (November, 1970), pp 78-81, and Idem, "Raschet osnovnykh pokazatelei narodnokhoziaistvennogo plana s primeneniem ekonomiko-statisticheskikh modelei" (Calculation of the basic indexes of the national-economic plan by means of an economic-statistical model), Planovoe khoziaistvo 49 (March, 1972), pp. 45-47.

repair of fixed assets in fact amounted to investment, by Western accounting practices. Indeed, in 1976 capital repairs for industrial equipment came to a total nearly 40 per cent as large as gross investment, and in the Ukraine in 1975 capital repair outlays for industrial equipment exceeded new equipment investment. As a consequence, one may safely conclude that $KREP_t$ contains an element of investment.[41]

Unfortunately, the data for $KREP_t$ are not published by major economic sector for the republics in this study, except for a few years for a few of the republics. Therefore, this variable must be deleted from equation (14b). Further, data disaggregated by major sector are not available for $VVOD_t$ for all the republics in this study. Consequently, equation (14) is written by substituting the expression for $VVOD_t$ from equation (14a) into (14b), with the omission of $KREP_t$ as noted. The omission of $KREP_t$ should be kept in mind for interpretation of the results. In equation (14), wdl should be interpreted as a retirement rate rather than a depreciation rate, since the data for K_t are taken from the books of Soviet firms, where the value of capital assets is carried without depreciation for wear and tear (bez vycheta iznosa).[42] One issue of considerable

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[41]Cohn, "Soviet Replacement Investment," pp. 240-245.

[42]The tables for basic funds (osnovnye fondy) in Soviet statistical handbooks carry the phrase bez vycheta iznosa (without deductions for wear [depreciation]) either as an explanatory note under the title or as a footnote. This point is elaborated in Raymond P. Powell, "The Soviet

importance for regional resource allocation is whether backward regions of the USSR (and Central Asia in particular) require more investment inputs to complete the same project, and whether completion times are longer.[43] It is of interest to see if estimation gives a different lag shape for the Baltic than for Central Asia.

Development of the investment equation for agriculture follows the same basic lines as for non-agricultural investment. Specifically, $RDEV_t$, DF_t, and $FYPCA_t$ serve generally the same function in equation (16) as they do in equation (13), and $PRIOAG_t$ serves the same function as $PRIO_t$. Calculation of $PRIOAG_t$ is by the formula

$$PRIOAG_t = (KA_t/KASU_t) \cdot IASU_t$$

where $KASU_t$ is the capital stock (fixed assets) in agriculture for the Soviet Union and $IASU_t$ is total Soviet social sector investment in agriculture. Green and Higgins have shown that there is a relationship between the state of the harvest and Soviet agricultural investment.

Capital Stock from Census to Census, 1960-1970," Soviet Studies 31 (January 1971), p. 58.

[43]Ann Sheehy, "Some Aspects of Regional Development in Central Asia," Slavic Review 31 (September 1972), p. 558, and E. K. Afanas'evskii, Legkaia promyshlennost': ekonomicheskie problemy razmeshcheniia (Light industry: economic problems of distribution) (Moscow: Mysl', 1976), pp. 118, 154-159, cited by Leslie Dienes, "Regional Economic Development," a paper presented at the Conference on the Soviet Economy Toward the Year 2000, Airlie House, Virginia, 23-25 October, 1980.

Specifically, they found that for the country as a whole a bad yield in agriculture was accompanied by a decline in investment in agriculture, followed by an increase the succeeding year.[42] This cycle is embodied in $PRIOAG_t$, so that a bad national harvest (dominated by conditions in the Ukraine) will be followed by a boost in agricultural investment in the Baltic and Central Asia (according to the logic of the model), even if it was a good year in those two regions. The nature of agricultural investment is such that gestation periods are generally much shorter than in non-agricultural sectors--hence the shorter lag structure on investment.[43]

To measure the relationship between regional agricultural output and regional agricultural investment, $AGCYC_t$ and $AGCYC_{t-1}$ are included in equation (16). A regional response to harvest conditions is reasonable, since Central Asia is the ultimate source of most of Soviet cotton textiles, and the Baltic a center of milk and meat production, the expansion of which has been an objective of the Brezhnev regime. In both cases, one would expect a bad year regionally to have national repercussions. Also, the harvest is an important factor in determining the ability of the kolkhozes to finance investment from retained earnings.

The data for $AGCYC_t$ are calculated by regressing QA_t in

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[42]Green and Higgins, SOVMOD I, pp. 145-148.

[43]Green and Higgins, SOVMOD I, p. 217 use this lag structure on agricultural investment.

current year rubles on a second degree polynomial in time (using $TIME^2$ or $TIME^{1/2}$, based on goodness-of-fit, in the third term), and then setting $AGCYC_t$ equal to the residual of that regression. The rationale is that the expectations of both the leadership and the peasantry are based on recent trends, and a "good" or "bad" year is defined in relation to those trends.

The last issue to be covered regarding the investment-capital formation block of the model concerns interpreting the role of the capital variable in the light of equipment utilization rates in agriculture. In Central Asia in particular, it has been reported that substantial amounts of the agricultural equipment carried on the books of the farms are in fact inoperative, due to shortage of spare parts (a perennial problem with Soviet machinery) and a lack of skilled personnel.[‘‘] This implies a difference between the measured and effective value of KA_t.

Wages in the model are determined in equation (19) for the non-agricultural sectors and in equation (20) for work on collective and state farms. The ideal approach for both sectors is to model wages as a function of the value of marginal product of labor in the affected sector.

However, this is not a feasible approach for the agricultural sector, for two reasons. First, it appears that agricultural wages are related to current-year ruble value of output. Successful estimation of the agricultural

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‘‘Wimbush and Ponomareff, Alternatives, pp. 24-25.

output equations would give the labor elasticity of output in comparable rubles, which is not directly applicable to current-year ruble average product values for computation of VMP_{LA}. Second, it turns out that the labor elasticity of output cannot be estimated with sufficient reliability for use here.

Accordingly, wages in the non-agricultural sectors are modeled as a linear function of VMP_L, with a shift for 1968. The shift is to capture the wage reforms of 1967, which did not take full effect until 1968. This form, shown above as equation (19), seems most appropriate. Tests of the proposition that $\partial W/\partial VMP_L$ also changed in 1968 are discussed in Chapter IV. The basic objective in equation (19) is to see if during the study period the Baltic became more attractive for investment, compared to Central Asia, in terms of labor costs.

The wage equation for agriculture is modeled in the same fashion, but with a shift for the agricultural wage reform of 1966, which affected the wage in the same year. The same functional form alternatives were explored as for non-agricultural wages. The outcomes for these alternative forms are also discussed in Chapter IV.

It has been noted that differences in regional wages in non-agriculture are fairly narrow in the USSR.[4'] If estimation of the model reveals substantial differences in

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[4']Gertrude Schroeder, "Regional Differences in Incomes and Levels of Living in the USSR," in Bandera and Melnyk, The Soviet Economy, p. 172.

the value of the marginal product (VMP_L) of labor, then a policy of wage equality could act detrimentally for investment in the region with the lower VMP_L. The reason is that in the Soviet Union substantial amounts of investment funds are allocated by the economic ministries based on output-maximizing criteria which include consideration of cost. The practice of paying equal wages would therefore act to inflate the wage bill in regions with a relatively less productive work force, and lead the ministries to prefer investment in other areas.

The issue in agriculture is complicated by the fact that collective farm wage determination methods have changed during the course of the study (most notably with the establishment of a minimum wage in 1966), and by the fact that the portion of total agriculture accounted for by the state farms has grown over the period of the study while that of the kolkhozes has shrunk. Further, the method of calculating "average annual" collective farm workers does not inspire confidence in its consistency. See Appendix A for a more complete discussion of the data.

One of the principal questions to be explored in this dissertation is whether or not Soviet economic policy acts to reduce regional inequality in consumption. A substantial amount of the increases in regional consumption, both total and household, can be explained by increases in NMP produced in the given region. The inclusion of $RDEV_t$ in both equations is to ascertain if, given NMP changes, changes in

relative development contribute to explaining consumption, and specifically if resources move interregionally to reduce inequality in consumption.

There are two ways in which the regime could underwrite consumption in less developed areas. The first is by means of state operation of certain activities, such as schools and hospitals (for a discussion of the division of output into consumption and accumulation, see Appendix A). Second, transfer payments to households and a policy of little regional wage inequality tend to make regional per capita consumption differences less than regional per capita NMP differences would suggest.

The structure of the model as actually estimated can be expected to vary slightly by region. For one thing, the possibility of different relationships between growth in agriculture and factor productivity in non-agriculture has already been mentioned. Second, intervention by the authorities in the action of the economy can vary from region to region; intervention by the government will be handled by the use of dummy variables. Deviations from the general form are identified and explained in Chapters III and IV as they arise.

CHAPTER III

METHODS OF ESTIMATION AND KEY RESULTS

The main objectives of this research are to determine the sources of growth in Central Asia and the Baltic, and to assess some relationships between Soviet economic policy and regional development. This chapter contains the results of estimating the key relationships for attaining those objectives: the production functions for both the agricultural and the non-agricultural sectors; investment in both sectors; and both total and private consumption. Since there are some special statistical considerations on account of the data problems involved, the chapter begins with a discussion of the econometric methods used in fitting the model.

Methods of Estimation.

The model elaborated in Chapter II contains 22 equations, of which 13 are non-identities requiring parameter estimation. Consistent estimates for these

equations have been accomplished using an instrumental variables (IV) technique; two-stage least-squares (2SLS) will not provide consistent estimation due to errors-in-variables involving some of the pre-determined variables. Because fitting this model did require care to obtain consistent estimates and it has much in common with other models using data of suspect quality, the particular approach taken here will be discussed at some length.

The most convenient framework is to start from four basic assumptions regarding the linear regression model:[1]

a) The disturbance term [the epsilons in equations (1) to (22)] has a zero mean;

b) The disturbance term is homoskedastic (i.e., $E(\varepsilon_t^2) = \sigma^2$ for all t);

c) The disturbances are serially uncorrelated (i.e., $E(\varepsilon_t \varepsilon_s) = 0$ for $s \neq t$);

d) The explanatory variables are independent of the disturbances.

If these assumptions are true, then ordinary least squares (OLS) estimation of the parameters in each equation yields results that are unbiased, BLUE (best linear unbiased), asymptotically unbiased, and consistent. Further, they have the same asymptotic distribution as maximum likelihood estimators based on a normal distribution of the error term.[2] Note that without a priori knowledge regarding the probability distribution of the disturbances,

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[1]Jan Kmenta, Elements of Econometrics (New York: Macmillan, 1971), pp. 202,301.

[2]Kmenta, Elements, p. 248.

efficiency cannot be ascertained. Further, unless the equation error terms are normally distributed the F and t ratios are without a formal theoretical basis. Fortunately, if the deviation from normality is not very radical, these tests of significance can be used as reasonable approximations.[3] This will be assumed to be the case.

If assumption d) above is violated, then ordinary least squares will have no desirable properties. There are two reasons to believe that there is contemporaneous correlation between explanatory variables and disturbances in the same equation. First, this is a simultaneous system, so that variables endogenous to the system but appearing in an explanatory role in a given equation are in fact correlated with the error term in that equation.[4] One commonly used single-equation estimating technique is 2SLS, which is itself essentially an IV process.[5]

If the pre-determined variables in the model are measured with a zero-mean random error, this will also produce a violation of assumption d) above and further interferes with 2SLS estimation, since the measurement error is incorporated into the instrument used to remove

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[3]E. Malinvaud, Statistical Methods of Econometrics (Chicago: Rand McNally, 1966), pp. 251-254.

[4]This is the "classic" problem of simultaneity bias. For a discussion, see, e.g., Kmenta, Elements, pp 533-534.

[5]The requirement for a variable Z_t to be a useable instrument for an explanatory variable X_t in a regression equation is that Z_t be correlated with X_t and uncorrelated with the (composite) error term. See Ibid., p. 309.

simultaneity bias.[6] Fortunately, the IV process can be extended to compensate for errors due to both the quality of the data and simultaneity bias, in a procedure very similar to 2SLS. The approach to estimation used in this model is a two step process.

In the first step, both endogenous variables that appear as explanatory variables and the pre-determined variables involving measurement error are regressed against the remaining pre-determined variables in the system. The results of those regressions are used to generate instruments for the endogenous explanatory variables and the erroneously-measured pre-determined variables.[7] In the second step, the structural equations of the model are estimated by means of IV, using the instruments constructed in step one. The results of this procedure are consistent estimates of the structural parameters. However, asymptotic efficiency cannot be asserted, and the small sample

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[6]Ibid.

[7]Of course, the quality of an IV estimation is a function of the correlation between an explanatory variable and its instrument. In a few cases, it was difficult to get a tight enough fit by limiting the first step right-hand-side variables to "correctly" measured pre-determined variables. In these cases, a fifth-degree polynomial on time was also entered into the first stage equation. This does not affect the properties of IV estimation, but it could conceivably permit the "estimation" of an under-identified equation. The rank conditions of a system of this size are not trivially determined; however, the order conditions show all the equations of the system to be conditionally overidentified (conditional on the rank conditions being fulfilled) by several degrees, taking into account the errors-in-variables (see Appendix B). Accordingly, as a practical issue the likelihood of this procedure leading to "estimation" of an under-identified

properties are not known.[4] For a more complete treatment of this procedure, and in particular a discussion of the identification issue (i. e., the question of whether or not there is sufficient information in the system to estimate all of the parameters), see Appendix B.

The errors-in-variables approach taken here is an explicit attempt to avoid as much as possible erroneous conclusions generated as a result of poor data. In this study, flaws in the data come in three forms: one, the published data cover the "right" concept but there are gaps in the series; two, the published data do not cover the appropriate concept, but are the basis for estimating the "right" series; and three, the data themselves are estimates subject to substantial error.

The capital stock series used here illustrates the first concept. The Latvian capital stock for all sectors is estimated for 1964, 1965, and 1969 based on assuming the (geometric) average growth rate over a gap prevailed for each year within the gap.

The non-agricultural sectors investment series is an example of the second type of data problem. The measure chosen for use in this study is investment in the non-agricultural productive sphere by "state and cooperative enterprises, excluding kolkhozes." Some republics aggregate investment in trade, procurement, material-technical supply,

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equation is quite small.

[4]Kmenta, Elements, pp. 310-311.

and forestry with non-productive sphere investment. The productive sphere share of this composite total is estimated by using the ratio from another year for the same republic, or the ratio from a republic with a similar economic structure (e. g., Latvian ratios were used to estimate for Estonia). Also, some republics publish only data inclusive of kolkhoz investment; this total is adjusted to a value net of kolkhoz investment by a similar process.

The best example of the third type of data deficiency is the series on defense expenditures. This is constructed by splicing together two western estimates of Soviet defense spending. While there are entries for every year, and the coverage used in the model is the same as the coverage reported, the data presented are themselves the result of an estimation process likely subject to substantial error.

Of course, the relevant question is to determine how much error is "substantial." Strictly speaking, all the variables used are subject to some error in the process of gathering, processing, compiling, and publishing statistical information. The difficulty lies in determining a priori which variables are enough in error that the results of estimation are misleading. This is largely a subjective decision, based on knowledge of the data set and the degree of precision required by the economic theorizing behind the model. In this study, if the data for a variable contain estimations (except for those contained in the official data), then that variable is treated as erroneously

measured. The "quality" of the data used in the model is appraised in Appendix A.

Violations of assumption b) and c) above, the statistical problems of heteroskedasticity and serial correlation, respectively, are explicitly treated more frequently in applied statistical work than is the errors-in-variables problem, even though the consequences for estimation are generally less severe. One reason for this is that the theory to deal with the problems of heteroskedasticity and serial correlation is more widely developed. Another must be that researchers are apparently willing to assume that the bias injected into their statistical estimates by ignoring data errors is not severe enough to influence the qualitative outcome of their works, if the number of cases where writers discuss the methods whereby they estimated portions of their data base and then fit their models without taking the fact of estimation into account is any indication.

Specifically, for the sort of heteroskedasticity possibly associated with the time-variable parameters, parameter variances estimates would tend to be underestimated and consequently the t-test be biased toward rejection of any specific hypothesis regarding a structural parameter.' While it is well to keep this effect in mind while evaluating the results given below, there is no evidence to point to substantial actual heteroskedasticity

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'Kmenta, Elements, pp. 254-256.

related to use of variable parameters in the model.

A possible source of heteroskedasticity in the model, and a complicating issue in detecting and remedying serial correlation, is the use of the pooled data approach to estimation. The data used to fit the model were gathered by republic in time series form. If we assume that the structural parameters for each of the republics within a region are the same, and that assumption is true, then pooling the data for the republics within the region improves the efficiency of estimation by effectively extending the sample size, compared to summing the observations across the republics of the region to obtain the aggregate values.[10] However, if the variance of the equation residual is different for each region, then the pooled data model is heteroskedastic. This difficulty seems not to be much of a problem for my model, except for those cases where the variables in an equation are measured more in error for one republic than they are for the others in a given region.[11] These cases are not the classic form of heteroskedasticity, and are not dealt with as such.

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[10]As noted above in Chapter *II* and elaborated in detail in Appendix C, for theoretic reasons it will not be possible to evaluate the role of agglomerative potential in economic growth by using pooled data.

[11]The best examples of this are equation (1.1) for the Baltic, where both the dependent variable (q_t) and one of the explanatory variables (k_t) are the product of substantial estimation for Latvia, and both equation (1.1) and equation (2.1) for Tadzhikistan, where q_t and qa_t are also measured with substantial error. These cases and their disposition are discussed below in Chapter IV.

Another result of pooling cross-sectional and time-series data is that detecting and dealing with serial correlation, the violation of assumption c) above, becomes much more complicated. First order autocorrelation is frequently a problem in time series studies, in a form such that $E(\varepsilon_t \varepsilon_s)$, $s \neq t$, is a constant over the series, for all pairs such that $|t-s|$ is the same. For pooled data, this is only true over the entries in the data set that come from the same cross-sectional units, or republics in this case. That is, if $\varepsilon_{i,t}$ is the disturbance for the tth observation on the ith republic, then $E(\varepsilon_{i,t}\varepsilon_{i,s}) = \rho_i^{|t-s|}$, where ρ_i is the coefficient of correlation between $\varepsilon_{i,t}$ and $\varepsilon_{i,t-1}$. However, $\rho_i \neq \rho_j$, $i \neq j$, where j refers to some other cross-sectional unit (republic). Consequently, the Durbin-Watson (D.W.) test statistic for serial correlation is only truly valid over the observations on a single republic within the total data pool, and the well-known methods to eliminate the effects of auto-correlation must also be applied separately to the data for each republic.[12]

With 6 republics in the survey, and 15 non-identity equations, there is the potential for 90 separate solutions to some procedure to correct for the effects of serial correlation. Since the effect is to reduce the efficiency of parameter estimates, but the property of consistency is retained in the presence of autocorrelation, my decision

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[12]These more common statistical problems associated with pooled data, along with their remedies, are treated at length in Kmenta, Elements, pp. 508-517.

generally has been not to remove the effects of autocorrelation from the data. The reasons for this are that to correct this complicated a model requires considerable computer and analyst time, and in the end the net gain is in the relative efficiency of the estimates.

The effects of serial correlation on statistical inference must be kept in mind, however. It has been shown for a two-variable linear model $Y_t = \alpha + \beta X_t + \varepsilon_t$ that when the coefficient of serial correlation (the above) is positive (indicated by a value of the Durbin-Watson statistic significantly less that two) and there is a time trend in the value of the explanatory variable, then serial correlation leads to a downward bias in the estimation of the variance of the estimated parameter β. The implication is that one would be more likely to reject any given hypothesis about a structural parameter using the t-test when in fact it is true than the stated probability of type I error.[13]

Some guide to the reliability of parameter variance estimates is needed. The D.W. statistic given with each equation provides a general indication, but the figure given is calculated for the equation as a whole. This is, loosely speaking, the weighted average of the values for each republic-section within the regional pool. However, the figure is also influenced by the "transition" in the data from one republic to the next. Several comparisons were

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[13]Ibid., pp. 278-282.

made between the equation average D.W. statistic and the values calculated for each individual republic within the pool. The total D.W. statistic was invariably representative of the three individual values, and in all but one case lay within the interval spanned by the largest and smallest of the republic values. The conclusion is that for this data set the total-equation D.W. statistic seems to provide a fair representation of the degree of serial correlation determined on individual cross-sectional unit in any given equation.

The Key Relationships

Estimates of the output, investment, and consumption equations are presented in this section. The results for both regions are given for each equation, to facilitate comparison. The presentation format (both for this chapter and for Chapter IV) is to give the numerical estimates of the structural parameters in equation form, with their standard errors below in parentheses. The values of the equation R^2, standard error, "average" D.W. statistic, and effective number of observations are then given below the equation. Deviations from the equation developed above in Chapter II are discussed as they arise. The results of each equation pair are interpreted below the presentation, vis a vis the issues involved. Unless otherwise indicated, tests of statistical significance are based on a probability of

type I error of .05.

The Production Functions.

Estimation of the basic Cobb-Douglas production function for non-agricultural output gives

$$\ln Q_t = \underset{(.048)}{.445} + \underset{(.004)}{.016}\ T50_t + \underset{(.062)}{.293}\ \ln K_t + \underset{(.069)}{.720}\ \ln L_t$$

R^2=.99819 SE=.03562 DW=1.6700 N=51

for Central Asia, and

$$\ln Q_t = \underset{(.377)}{-1.87} + \underset{(.008)}{.018}\ T50_t + \underset{(.111)}{.536}\ \ln K_t + \underset{(.066)}{.785}\ \ln L_t$$

R^2=.99304 SE=.04494 DW=.7222 N=52

for the Baltic.

Surprisingly, there is little difference between the rate of increase in joint factor productivity in the two regions. The most striking difference between the two regions in the structure of production is the difference in the economies of scale, due almost entirely to differences in the capital elasticity of output. The likelihood of a difference in economies of scale has been noted by other writers, and was expected.[14] Comparisons of the values of

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[14]Alexander Woroniak, "Regional Aspects of Soviet Planning and Industrial Organization," in V. N. Bandera and

marginal product (VMP) of capital and labor for the two regions are given in Table III.1 and Table III.2.

TABLE III.1

VMP OF CAPITAL (NON-AGRICULTURE)
(1965 Rubles of Output Per 1955 Ruble of Capital Input)

Year	The Baltic			Central Asia		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1960	.4725	.4738	.3345	a.2599	.3379	.2815
1965	.4613	.4489	.3325	.2322	.2762	.2220
1970	.4985	.4681	.3632	.1939	.2374	.2140
1977	.4425	.4232	.3447	.1745	b.1921	.1689

a: 1961 value b: 1976 value

The regional differences in the VMP of capital (VMP_K) widened substantially over the period. In fact, the VMP_K for Estonia actually increased over the study period, and the VMP_K diminished only slightly for the other Baltic republics during the period, but the VMP_K for all the Central Asian republics fell considerably. On the other hand, while the VMP of labor (VMP_L) increased steadily for both regions during the study period, on the average the increase for the Baltic republics was twice as great as for the Central Asian ones. Further, Table A.10 reveals that

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Z. L. Melnyk (eds.), The Soviet Economy in Regional Perspective (New York: Praeger, 1973), p. 277, and A. B. Margolin (ed.), Pribaltiiskii Ekonomicheskii Raion (The Baltic Economic Region) (Moscow: Nauka, 1970), p. 18.

TABLE III.2

VMP OF LABOR (NON-AGRICULTURE)
(1965 Rubles of Output Per Worker)

Year	The Baltic			Central Asia		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1960	1934	2132	1835	1973	1852	1801
1965	2345	2590	2306	2248	2135	2205
1970	3232	3582	3241	2670	2576	2649
1977	4465	5084	4581	3517	a3019	a3190

a: 1976 value.

the wage rate in 1960 was roughly equal across all the republics of the study sample, as was the VMP_L. By 1965, wages were still roughly equal, but by then the lowest VMP_L in the Baltic (Estonia, which also had the highest wage) exceeded the highest VMP_L in Central Asia. By 1977, average wages in the Baltic only exceeded those in Central Asia by 13 per cent. However, the VMP_L in the Baltic exceeded the VMP_L in Central Asia by 45 per cent.

These particular facts bring up an important point, to be discussed further in Chapters IV and V. That is, if investment location decisions in the Soviet Union are primarily based on minimizing the "social labor costs" of a project, and the wage bill may be taken as an effective measure of "social labor costs," then the Baltic became progressively more attractive for investment in non-agricultural activities than Central Asia during the sixties

and seventies.[11]

The above results of estimating Q have been used to analyze regional differences in growth; the results of that analysis are in Chapter V. When this analysis is done on the basis of five-year intervals, growth in factor productivity (defined as the residual between the actual growth rate and the rate of growth that can be explained by growth of inputs, including growth due to economies of scale), substantially greater rates of Hicks-neutral productivity growth are implied for the Baltic for the period of the eighth plan, 1966-1970. This shows up as a markedly greater rate of productivity growth from 1967 to 1969 in the growth equations in Chapter IV; in the growth equations it is easier to isolate such phenomena. This matter is discussed more fully in that chapter.

Fitting a production function for agricultural output was not as successful, due to deficiencies in the data for virtually every variable involved. Perhaps the most serious deficiency is in the measure for QA, comparable ruble NMP created in agriculture. Some particular problems with the Lithuanian data, which provide the implicit deflators used to estimate the deflators for some of the years for Latvia

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[11]Writing in the early seventies, Alexander Woroniak commented "...practically all major works published in the Soviet Union during the past 10-15 years on location of productive facilities approach the issues from the point of economizing on social labor costs," and the approach also underlies the officially approved methods of determining capital investment efficiency. See Alexander Woroniak, "Regional Aspects," p. 273.

and Estonia, are discussed at length in Appendix A. In general, the most serious problem seems to be an inadequate method for accounting for price changes.

While the results are better for Kirgizia and Central Asia as a whole.(in the sense that there are fewer outlandish inconsistencies), problems nonetheless remain. The better estimation results for Central Asian agriculture (better compared to the Baltic results) seem due to better (in the sense that it seems more consistent with aggregate NMP data) output measures.

In an attempt to circumvent the shortcomings of the output measures, two alternative definitions of QA were tried. First, a variable $QADIF_t$, defined as $NMP_t - Q_t$, gave marginally better results for the Baltic, and economically more satisfying results for Central Asia. These results are presented below. Second, estimates of QA_t based on deflators from Soviet national agricultural growth indexes for 1960-1975 were used, to test the proposition that the problem is due to the use of Kirgiz and in particular Lithuanian data for estimating deflators for the other republics in their respective regions.[14] This procedure yielded poorer results than those from the data described in Appendix A.

The data used to measure inputs of capital and labor

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[14]These estimates were taken from Daniel L. Bond, "Multiregional Economic Economic Development in the Soviet Union: 1960-1975" (Ph. D. dissertation, University of North Carolina, 1979), p. 222.

are also subject to error, aside from errors of estimation. Capital stocks on the books of farms, especially in Central Asia, may not accurately reveal the actual availability of fixed assets. Unserviceability of machinery is a frequent problem, due to shortages of parts and skilled repairmen, and due to improper use by unskilled operators.[17] As a result, the capital listed in farm accounts is not the actual serviceable capital in use.

The shortcomings of the official employment data in socialized agriculture are discussed in Appendix A. The chief problem with the "average annual number of workers" measure is that it is too coarse to capture changes in the total number of days worked in agriculture, much less the hours worked. A specific problem is that in Central Asia the reported work force has grown, but there is some evidence that the effective labor force has not grown by as much as the official figures indicate. As is often the case in less developed rural areas, to a large degree existing work seems to have been divided among a larger number of workers, with a diminution of the amount of work done by each farmer.[18]

Estimation of equation (2) using official agriculture output data gives

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[17]S. Enders Wimbush and Dmitry Ponomareff, Alternatives for Mobilizing Soviet Central Asian Labor: Outmigration and Regional Development (Santa Monica: The RAND Corporation, R-2476-AF, 1979), pp. 24-25.

[18]Underemployment in Central Asia is discussed in, e. g., Ibid., pp. 5-6.

$$\ln QA_t = \underset{(2.27)}{-3.15} - \underset{(.585)}{.788}\, UZ_t - \underset{(.166)}{.045}\, KI_t - \underset{(.035)}{.007}\, T50_t + \underset{(.385)}{.126}\ln KA_t + \underset{(.426)}{.893}\ln LA_t + \underset{(.333)}{.522}\ln TR_t$$

R^2=.99181 SE=.06547 DW=1.7382 N=52

for Central Asia, and

$$\ln QA_t = \underset{(13.5)}{10.5} + \underset{(2.07)}{1.78}\, LI_t + \underset{(1.25)}{.894}\, LT_t - \underset{(.042)}{.017}\, T50_t + \underset{(.360)}{.056}\ln KA_t + \underset{(6.76)}{.430}\ln LA_t - \underset{(.636)}{.788}\ln TR_t - \underset{(.003)}{.007}\, RAIN_t + \underset{(.047)}{.127}\ln FERT\%$$

R^2=.94786 SE=.11177 DW=.9595 N=52

for the Baltic. Estimation defining $QADIF_t$ as agricultural output gives

$$\ln QADIF_t = \underset{(2.60)}{-.757} - \underset{(.669)}{.130}\, UZ_t + \underset{(.190)}{.188}\, KI_t - \underset{(.040)}{.028}\, T50_t + \underset{(.440)}{.534}\ln KA_t + \underset{(.487)}{.471}\ln LA_t + \underset{(.381)}{.157}\ln TR_t$$

R^2=.98958 SE=.07487 DW=1.9966 N=52

for Central Asia, and

$$\ln QADIF_t = \underset{(12.4)}{-5.31} - \underset{(1.90)}{.605}\, LI_t - \underset{(1.15)}{.478}\, LT_t + \underset{(.039)}{.019}\, T50_t + \underset{(.331)}{.101}\, \ln KA_t + \underset{(6.21)}{6.82}\, \ln LA_t - \underset{(.584)}{.063}\, \ln TR_t - \underset{(.0003)}{.001}\, RAIN_t + \underset{(.043)}{.079}\, \ln FERT\%_t$$

R^2=.95307 SE=.10275 DW=1.0019 N=52

for the Baltic.

Indexes for temperature deviations were tried for both regions without significant results, and rainfall indexes were not useful in explaining agriculture output in Central Asia. Briefly, the reasons are that the temperature indexes are based on monthly average observations, and are too coarse to capture a disaster (late freezes or the Sukhovei, which are hot, desiccating winds of a few hours duration), and the reporting stations for rainfall in Central Asia are not located in the most appropriate place to measure agriculturally relevant precipitation.

The statistical weakness of the results makes conclusions difficult to draw. Even choice of QA or QADIF as the most appropriate measure of agricultural output is difficult, based on the regression results. On the whole, the results above for agriculture and the results of growth relationships based on same (Cobb-Douglas type) production function presented in Chapter IV can at best be used in conjunction with other data for impressionistic

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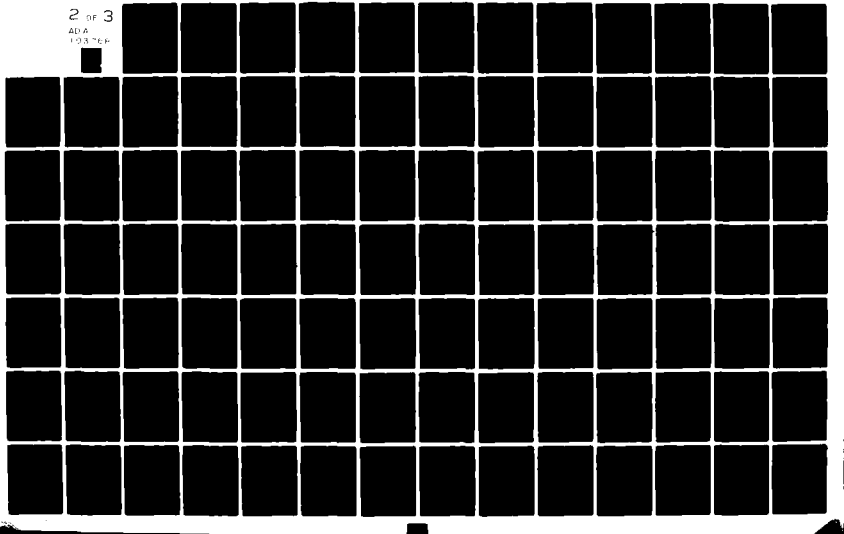

conclusions.[1']

Regional differences in the marginal products of capital and labor in agriculture are important to assess certain Soviet issues in Soviet policy with important regional implications. Because of the weakness of the regression results, the method will be to present the output-to-factor (capital or labor) ratios for benchmark years, and then speculate on factor marginal products based on those ratios and the regression results.

Tables III.3 and III.4 contain data on the average product of capital and the average product of labor, respectively. Note that the average product of labor in agriculture (AP_{LA}) (and therefore the VMP_{LA} in the Cobb-Douglas model) increased from 1970 to 1977 in only one republic--Uzbekistan. Further, the output-to-capital ratios in the two regions were about equal in 1960; however, by 1977 they were on the average 60 per cent greater in Central Asia. Since the capital elasticity of output estimates were uniformly larger (in a numeric sense) for Central Asia, it

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[1']Green and Higgins in the report on SOVMOD I mention that theirs is the first successful estimation of a production function for Soviet agriculture. In that project, they had considerably greater resources than are available here, and were using aggregate Soviet data, which seems less heir to the problems discussed above and in Appendix A regarding output series for agriculture. Here the results of estimation using $QADIF_t$ seem plausible for Central Asia, even though the t-ratios are not as strong as the results using QA_t. However, the equation results imply that the relationship as a whole is significant, and the economic results are more reasonable in that version than using QA_t. Neither of the Baltic estimations makes a lot of economic sense. Accordingly, regional comparisons can only be made in a very general sense.

seems likely that the value of the marginal product of capital was substantially larger in Central Asia than in the Baltic by the end of the period. Note that while the rate of capitalization grew faster on a per worker basis in the Baltic than in Central Asia over the course of the study period, that was due to differences in the rate of expansion of the agricultural work force, which was negative in the Baltic. The absolute amount of capital available in agriculture grew at a rate about 25 per cent greater in Central Asia than in the Baltic from 1960 to 1977.

TABLE III.3

AVERAGE PRODUCT OF CAPITAL (AGRICULTURE)
(NMP in 1965 Rubles, Capital in 1955 Rubles)

Year	Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1960	1.06	.96	.91	a1.01	1.00	1.03
1965	.86	.63	.64	.90	.78	.69
1970	.59	.48	.46	.62	.57	.50
1977	.21	.17	.21	.32	b.33	.28

a: 1961 value b: 1976 value

It is more difficult to assess the trends and levels in VMP_{LA} due to the severe unreliability of the estimates for the labor elasticity of output in the Baltic. Based on differences in the average products, and the results of attempting a number of different estimates of QA, it seems

TABLE III.4

AVERAGE PRODUCT OF LABOR (AGRICULTURE)
(1965 Rubles Per Worker)

Year	Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1960	1924	2176	2589	1358	1706	1286
1965	2211	2394	2968	1535	1911	1461
1970	2555	2535	3394	1690	2053	1639
1977	2208	1830	3019	1716	a1830	1459

a: 1976 value

likely that VMP_{LA} is higher in the Baltic than in Central Asia, though quantitative estimation of the difference is not possible on a reliable basis, given the information available.[2*]

It also seem likely that the VMP_K is larger than the VMP_{KA} for both regions. At the same time, it is also likely that VMP_L exceeds VMP_{LA} in both regions. The implication is that the ruble value of total output in both regions would be increased by transferring resources out of agriculture and into non-agriculture. It has already been pointed out that ruble values may not accurately reflect the priorities of the regime, however.

[2*]In particular, estimation using exactly the same variables as appear in the Central Asian estimates that appear above yields a labor elasticity estimate on the order of 2.0.

Investment

Investment both in agriculture and in non-agriculture is a crucial aspect of growth in the Soviet economy. First, investment differences lead ultimately to differences in the capital stock, other things being equal. Second, understanding the investment process is critical to understanding the regional influence of Soviet economic policies. Below investment is estimated for the two sectors separated for this study for both regions.

Estimation of equation (13), non-agricultural investment, gives

$$I_t = \underset{(51.7)}{175.6} + \underset{(.177)}{.820}\ PRIO_t - \underset{(.029)}{.005}\ RDEV_t - \underset{(1.31)}{3.41}\ DF_t + \underset{(23.0)}{50.3}\ DPLAN8_t + \underset{(22.9)}{6.30}\ FYPCA_t$$

R^2=.96337 SE=73.215 DW=.3344 N=52

for Central Asia, where $DPLAN8_t$ is a dummy variable taking on a value of one during the period of the eighth five-year plan (1966-1970) and a value of zero otherwise. The reason for including $DPLAN8_t$ is that transfers of resources into the Central Asian republics were particularly strong during this period, apparently for the purpose of investment.[21]

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[21]James W. Gillula, "The Economic Interdependence of Soviet Republics," in Joint Economic Committee, 96th Congress, 1st Session, Soviet Economy in a Time of Change

For the Baltic,

$$I_t = \underset{(19.5)}{77.9} + \underset{(.082)}{1.11}\ PRIO_t - \underset{(.019)}{.006}\ RDEV_t - \underset{(.856)}{4.16}\ DF_t - \underset{(8.88)}{23.7}\ FYPCA_t$$

R^2=.94277 SE=28.014 DW=.5893 N=51.

In the equation estimate for Central Asia, the significance and the sign on the dummy variable $DPLAN8_t$ confirm Gillula's speculation that the above-normal transfers of funds into Central Asia during the period of the eighth plan were to finance above-normal investment. A similar dummy for the ninth plan period (1971-1975) was not statistically significant in the equation.

The role of $PRIO_t$ in each equation is to indicate the amount of investment a region could expect, based on the composition of its capital stock in the non-agricultural sectors and the national sectoral allocations of investment. Its value indicates the amount of investment each republic could expect to receive to preserve its share in the national capital stock by sector and industrial branch. The numerical difference between Central Asia and the Baltic in the coefficient on $PRIO_t$ suggests that other factors in the equation being equal, planners showed a higher preference

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(Washington, D. C.: Government Printing Office, 1979), vol. 1, pp. 630-636.

for investments in the Baltic than in Central Asia during the period of this study. This would be consistent with the findings in the different versions of equation (1) and the growth priority.

One of the central issues in this study is to determine if, as the Soviets put it, "leveling the development of the regions" is a true objective of investment location policy in the Soviet Union. One has to recognize the limitations (and the strengths) of time series analysis in answering this question. Over the period as a whole, the Baltic has been prosperous and Central Asia poor. However, there has been movement in the relative prosperity and poverty during the study period, and in Lithuania in some of the earlier years per capita incomes were actually below the Soviet average.

The results are quite similar for both regions. The sign on $RDEV_t$ is negative, as would be the case if the spatial allocation of investment were sensitive to the regional development. However, neither coefficient is statistically different from zero, by any reasonable confidence interval. One is therefore led to reject the hypothesis that equalizing levels of development is a substantial factor in Soviet non-agricultural investment policy.

Another important issue is the relationship between Soviet defense efforts and investment in border areas. It was pointed out in Chapter II that because the sectoral

investment displacement effect of defense expenditures is already captured in $PRIO_t$, the coefficient on DF_t is a locational effect.[22] For both regions, which are located on the edges of the Soviet Union, the coefficient is negative, statistically different from zero, and of roughly the same magnitude. The conclusion is that higher defense expenditures in the Soviet Union are particularly burdensome for both the Baltic and Central Asia, and by implication for other areas located on the borders. In part, the reasons are historical, going back to the re-location of heavy industries serving defense to protected areas (the Ural area, western Siberia, and Kazakhstan) before and during the Second World War. These locational decisions appear not to have been reversed. Continued construction of defense plants in the RSFSR and Kazakhstan has been reported by other writers.[23] While it has been argued that the possibility of a thermonuclear strike could motivate dispersion of Soviet industries serving defense, such dispersions need not be on the order of inter-republic distances to be effective, especially if one expects his potential adversary to concentrate on more immediate targets of a military nature. Further, investigation reveals that

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[22]Of course, if a branch of industry called "defense industries" were identified in the data, then defense plant location could be determined in a more direct fashion, and the only effect would be the sectoral one.

[23]Ivan S. Koropeckyj, "Industrial Location Policy in the USSR During the Postwar Period," in Joint Economic Committee, 91st Congress, 2nd Session, Economic Performance and the Military Burden in the Soviet Union (Washington,

for the Baltic and Central Asia there has been no statistically significant change in the relationship between investment and defense expenditures over the course of this study.

The interpretation of $FYPCA_t$ in this equation is also mainly spatial, due to the composition of $PRIO_t$. For Central Asia, the results indicate that the plan cycle effects are fairly similar to that of the Soviet economy as a whole. But for the Baltic, the coefficient is negative and statistically different from zero. One possible reason for this has to do with the sub-branch composition of industry. Part of the theoretical argument behind the plan cycle is that investment in the producer goods industries, mostly assigned to the machine tools and metal working branch of industry, will be particularly favored early in a five year plan, with investment in other industries being relatively greater, later in the period. Because in the Baltic the concentration within the machine tools and metal working branch is in consumer durables and agricultural equipment, $PRIO_t$ over-assigns investment priority in the early years of the plan, and under-assigns it in later years.[24] As a consequence, the strong, negative coefficient on $FYPCA_t$ is perhaps simply a correction for the coarseness of the $PRIO_t$ index.

D. C.: Government Printing Office, 1970), pp. 262-264.

[24]See footnote 4, Chapter IV, for an enumeration of the consumer goods industries located in the Baltic.

For agricultural investment, estimation of equation 16 gives

$$IA_t = \underset{(27.1)}{237.3} + \underset{(.132)}{1.16}\ PRIOAG_t - \underset{(.014)}{.034}\ RDEV_t - \underset{(.0007)}{.007}\ DF_t + \underset{(.060)}{.0008}\ AGCYC_t + \underset{(.076)}{.005}\ AGCYC_{t-1} - \underset{(12.9)}{12.8}\ FYPCA_t$$

R^2=.99078 SE=37.009 DW=.6246 N=48

for Central Asia and

$$IA_t = \underset{(14.7)}{9.01} + \underset{(.042)}{.763}\ PRIOAG_t - \underset{(.011)}{.030}\ RDEV_t + \underset{(.0005)}{.0008}\ DF_t + \underset{(.096)}{.237}\ AGCYC_t - \underset{(.111)}{.026}\ AGCYC_{t-1} - \underset{(7.10)}{3.23}\ FYPCA_t$$

R^2=.96341 SE=19.027 DW=1.0316 N=49

for the Baltic. As was the case for non-agricultural investment, the original reason for including the variable $PRIOAG_t$ was to allow evaluation of the effects of Soviet policy regarding development and defense, and the strength of regional "crisis response," with the national agricultural investment decision taken into account.

The most important finding, in terms of this study, is that there is a significant relationship between regional development levels and investment in agriculture. Specifically, the lower the regional level of development,

compared to the the national average, the greater the agricultural investment, other factors included in the equation being equal.

There are three circumstances that could contribute to this finding. First, in the Soviet Union poorer regions tend to have above-average portions of their population employed in agriculture at low income and productivity levels. To make the very poor better off, and preserve some sort of relationship between productivity and income (for incentive effect), it would be reasonable to invest in agriculture in less developed regions. Second, the better developed regions tend to have more prosperous and more heavily capitalized farmers (compare the data in Tables A.6 and A.22). The discussion above in this chapter suggests that putting agricultural investment more into Central Asia makes economic sense from the output-maximization perspective. Finally, Central Asian cotton is an export crop. Cotton was the leading Soviet agricultural export, and the third most valuable export product over all (behind oil and gas) in 1976.[25] Therefore, a desire to augment foreign exchange availability could imply a preference for agricultural investment in Central Asia.

For the reasons given in the above paragraph, one cannot assert that the statistical relevance and the sign on $RDEV_t$ are not due to correlation between $RDEV_t$ and other considerations. However, there is certainly no basis for

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[25]Wimbush and Ponomareff, Alternatives, p. 21.

rejecting the hypothesis that reducing regional inequality has not been an objective of the spatial allocation of agricultural investment.

The defense variable is a significant factor only for Central Asia, where the effect is again to displace investment. Crisis-intervention is a relevant factor only for the Baltic, for the current year. The sign of the coefficient on $AGCYC_t$ for the Baltic (positive) indicates that in a bad year, investment is reduced. There are two possible reasons for this. First, in a bad harvest year collective farm self-finance capability is reduced. Second, and in the Soviet context perhaps more important, one can speculate that resources that would have otherwise gone to investment are transferred to current operations, to maintain livestock herds.[24]

As in the non-agricultural sectors, the coefficients on $PRIOAG_t$ deviated from one in the estimation, and by a significant amount in the case of the Baltic. These values imply that the share of the national agricultural capital stock located in the Baltic is falling, and that in Central Asia is increasing. The reasons for the increase in Central Asia may be at least partly political. In particular, the mechanization of agriculture is an objective that has begun

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[24]Meat and dairy operations are a Baltic agricultural specialty. For a discussion of efforts to prevent distress slaughter following the 1975 drought, see David W. Carey, "Soviet Agriculture: Recent Performance and Future Plans," in Joint Economic Committee, 94th Congress, 2nd Session, Soviet Economy in a New Perspective (Washington, D. C.: Government Printing Office, 1976), pp. 583-585.

to take on importance almost is its own right. The political leadership in Central Asia presses strongly for further capital investment, even in the face of surplus labor. Development of Central Asian agriculture is important as a Soviet showpiece, as well. Thus, the confluence of a number of essentially political issues leads to an increase in the share of agricultural capital going to Central Asia.

A larger share of agricultural investment to Central Asia and a smaller share to the Baltic than one would expect, given the existing capital distribution, is also reasonable in strictly economic terms. It is shown above that the average product of capital is greater in Central Asia than in the Baltic, and argued that it is more than likely true that the difference in the VMP_{KA} is even larger. Consequently, it would be reasonable to direct a larger share of new capital to Central Asian agriculture than was the case in the past.

Consumption.

Estimation of equation (21), total consumption, gives

$$C_t = \underset{(63.2)}{53.8} + \underset{(.042)}{.603}\ NMP_t - \underset{(.044)}{.294}\ RDEV_t$$

R^2=.99904 SE=95.697 DW=1.8197 N=27

for Central Asia, and[27]

$$C_t = \underset{(17.60)}{169.2} + \underset{(.008)}{.664}\ NMP_t - \underset{(.027)}{.054}\ RDEV_t$$

R^2=.99698 SE=45.370 DW=1.1568 N=47

for the Baltic. Estimation of equation (22), private consumption, gives

$$CPVT_t = \underset{(72.5)}{58.5} + \underset{(.046)}{.549}\ NMP_t - \underset{(.046)}{.256}\ RDEV_t$$

R^2=.99832 SE=92.383 DW=1.2809 N=23

for Central Asia, and

$$CPVT_t = \underset{(25.7)}{110.6} + \underset{(.046)}{.665}\ NMP_t - \underset{(.150)}{.248}\ RDEV_t$$

R^2=.99573 SE=42.513 DW=1.0092 N=29

for the Baltic.[28]

The results for the total consumption equations provide statistically significant support for the contention that

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[27] The only observation available for Tadzhikistan is for 1966.

[28] The loss of observations is due to the fact that some republics for some years report the size of the total consumption fund, but do not disaggregate it. In particular, Lithuania does not publish the division of consumption into public and private components for any year.

Soviet government policies act to lessen inequality in consumption. For Central Asia, the same conclusion is born out for private consumption. However, while the coefficient on $RDEV_t$ is negative in the Baltic equation for private consumption, the t-statistic has a value of -1.65, which lies on the rejection frontier at the .05 confidence level.

The implication is that there is a strong relationship between the level of regional economic development (measured by per capita NMP produced) and public consumption (the operation of the educational system, health care, and the like).[21] To test this proposition, the relationship

$$CPUB_t = \omega'_0 + \omega'_1 NMP_t + \omega'_2 RDEV_t + \varepsilon_{CPUB,t}$$

was estimated. For Central Asia, the results are

$$CPUB_t = \underset{(16.8)}{59.1} + \underset{(.011)}{.029}\ NMP_t - \underset{(.011)}{.054}\ RDEV_t$$

R^2=.99142 SE=21.425 DW=1.1020 N=23

for Central Asia, and

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[21]More detailed discussion of the activities included in public consumption is in Appendix A.

$$CPUB_t = \underset{(8.18)}{4.91} + \underset{(.015)}{.123}\ NMP_t - \underset{(.048)}{.188}\ RDEV_t$$

R^2=.96685 SE=13.546 DW=.9965 N=29

for the Baltic. The results confirm the notion that government policy acts toward equalization of public consumption per capita.

One notices immediately that, in the above formulations, the change in consumption brought about by a change in NMP is greater for the Baltic than for Central Asia. This is somewhat surprising, given the development levels of the two regions. Estimation of a two-variable relationship between consumption and produced NMP gave a marginal propensity to consume on the order of .6 and .8 for the Baltic and Central Asia, respectively. The smaller values in the equations presented above are due to the fact that in Central Asia the development index ($RDEV_t$) has been getting larger in absolute value throughout the study period, as have NMP produced and all types of consumption. This influences the size of the coefficient on NMP_t, which measures the increase in consumption attributable to NMP_t but independent of $RDEV_t$.

The principal mechanisms whereby the government effects its consumption policies are transfers via the state budget, and by wage policy. The regional aspects of Soviet wage policy are discussed below in Chapter IV. Briefly, wages are less unequal across regions than are labor

productivities, with the result that private consumption in poorer (lower productivity) regions is effectively increased from what would be the case with a uniform relationship across regions between wages and labor productivity. In a previous study, Gillula showed that during most of the period covered in this study resources were transferred into the Central Asian republics, and out (on the whole) of the Baltic republics, though Lithuania was something of an exception.[30] The resources used in consumption moved on an inter-republic basis by means of the operation of certain activities by the state (education, public health, passenger transportation, transfer payments, etc.), and by means of wage policy. While public consumption activities are officially conducted by republic and lower organizations, the resources for their operation depend on central decisions, principally regarding what portion of the turnover tax collected in a republic remains there, rather than being forwarded to Moscow.

Private (household) consumption is influenced by means of wage policy (see Chapter IV) and government transfers. Transfers, which have increased rapidly since the death of Stalin, include pension, student stipends, and family allowances for low-income families (introduced in 1974).[31]

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[30]James W. Gillula, "The Economic Interdependence," pp. 630-636.

[31]Gertrude Schroeder and Barbara Severin, "Soviet Consumption and Income Policies in Perspective," in Joint Economic Committee, 94th Congress, 2nd Session, Soviet Economy in a New Perspective (Washington, D. C.: Government

Further, depreciation of the housing stock is included in private consumption.[32] These all tend to reduce inequality in private consumption.

The conclusions regarding the effect of Soviet policy on regional variations in consumption is that it acts to reduce inequality. This is particularly true for public consumption. While the over-all effect is to reduce inequality in private consumption, the effects have been felt far more strongly in the poorer region of Central Asia than the richer region of the Baltic. That is, the benefits accruing to Central Asia in terms of household consumption have been persistent. Consumption there is drawn closer to the national average. On the other hand, high wages (and high labor participation rates) in the Baltic have tended to keep household consumption high there, though there is some evidence of pressure toward the national mean.

Printing Office, 1976), p. 628, and Alastair McAuley, "Personal Income in the USSR: Republican Variations in 1974," in NATO, Economic Directorate and Directorate of Information, Regional Development in the USSR (Newtonville, Mass.: Oriental Research Partners, 1979), pp. 42, 52.

[32]NARKHOZ 1963, p. 503. If inequality in state housing is less than the inequality in per capita NMP, then state housing policy acts, effectively, to reduce regional inequality in consumption, given NMP.

CHAPTER IV

ESTIMATION OF THE GROWTH EQUATIONS, CAPITAL FORMATION, LABOR SUPPLY, AND WAGES

The remainder of the estimated model is presented below by equation, in the same format as used in Chapter III. As was the case in Chapter III, the results for each equation are discussed after they are presented, but observations, conclusions, and speculation regarding the system as a whole are reserved for Chapter V.

The Growth Equations.

There are three versions of the non-agricultural sector growth equation, differing in how "factor productivity growth" is treated. The simplest, combining equation (1.1) with equation (1.1a), gives the general form

$$(1.1.a) \quad q_t = (\beta_0 + \beta_1 qa_t) + \alpha_1 k_t + \alpha_2 l_t + \epsilon_{q,t}.$$

Because substantial estimation was used in arriving at values for Q_t for Tadzhikistan (see the discussion in Appendix A), inclusion of Tadzhik data in the estimation of

equation (1.1.a) for Central Asia is apt to inject considerable noise. Estimation pooling only the data from Uzbekistan and Kirgizia gives

$$q_t = \underset{(.023)}{.012} + \underset{(.059)}{.096}\, qa_t + \underset{(.238)}{.496}\, k_t + \underset{(.353)}{.268}\, l_t$$

R^2=.34174 SE=.02776 DW=2.4541 N=32

Estimation by including the Tadzhik data gives very poor results, and estimation of the equation for Tadzhikistan alone gives miserably poor results. Since the entire value-added series for Tadzhikistan was estimated, the conclusion is that the quality of the Tadzhik data for this equation is poor enough that it interferes with statistical inference. Therefore, further estimation of non-agricultural output growth in Central Asia will be based on data from Uzbekistan and Kirgizia only.

The hypothesis of regional economic homogeneity was also tested using equation (1.1.a) and an F-test for the relevance of additional explanatory variables added to allow a separate set of parameters for each republic.[1] The results substantiated the findings from the production function; that is, there was no significant gain by allowing separate parameters, and the hypothesis of homogeneity therefore cannot be rejected.

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[1]This test is described in, e. g., Jan Kmenta, Elements of Econometrics (New York: Macmillan, 1971), pp. 370-371.

As was the case for Central Asia, the data for one Baltic republic, Latvia, were known to be of poorer quality, due to substantial estimation of both Q_t and K_t.[2] Accordingly, equation (1.1.a) was estimated by pooling the data from Lithuania and Estonia, with the following results:

$$q_t = \underset{(.021)}{.018} + \underset{(.354)}{.562}\, k_t + \underset{(.340)}{.392}\, l_t + \underset{(.034)}{.047}\, qa_{t-1} + \underset{(.007)}{.328}\, D6769_t$$

R^2=.78331 SE=.01277 DW=2.2563 N=31.

Like the case for Tadzhikistan in Central Asia, efforts to fit the model using data from Latvia only were not successful. As for Central Asia, equation (1.1.a) was used to test for regional homogeneity. Again, the hypothesis of homogeneity cannot be rejected by means of the F test described above. This is true regardless of whether the two-republic or the three-republic version is used.

Here $D6769_t$ is a dummy variable with a value of one for the years 1967 through 1969 and zero otherwise. The rationale for this variable is that following the wage reform of 1967, consumer goods may have enjoyed a period of higher than normal priority, both for political reasons and to validate the higher wages. However, as growth rates began to lag in 1969, heavy industries turning out producer

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[2]Examination of the residuals from the Baltic region estimate of equation (1.1.a) also revealed a much greater variance for Latvia than for Estonia or Lithuania.

goods regained their usual priority.[3] The relevance of $D6769_t$ in the growth equation implies that the priority nature of the economy extends beyond investment allocation to intervention in the economy, e. g. to insure smooth movement of input supplies to priority sectors. One could expect $D6769_t$ to be important for the Baltic, since a wide range of consumer goods is produced there;[4] it was also tried in the Central Asia estimations, where it added nothing to the explanation of growth. The latter is interesting, since light industry is relatively more concentrated (as measured by locational quotients) in Central Asia than the national average. On the other hand, though, Central Asia does not meet its own textile needs, so

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[3]Donald W. Green and Christopher I. Higgins, SOVMOD I: A Macroeconomic Model of the Soviet Union (New York: Academic Press, 1977), pp. 135-139.

[4]Consumer goods industries in the Baltic which produce a substantial share (considering the size of the region) of total Soviet output include the following: from machine building and metalworking, radios, televisions, record players, tape recorders, mopeds, motorbikes, bicycles, telephone equipment, and refrigerators; from light industries, cotton, woolen, silk, and linen textiles, knit under- and outer-wear and hosiery; and from food industries, fish, meat, and dairy products. The material base for much of Baltic light industry is in Central Asia (textiles), Kazakhstan, the Ukraine, and the North Caucasus (hides and wool). In addition to these consumer goods, the machine building and metal working branch of industry in the Baltic produces agricultural equipment. See A. B. Margolin (ed.), Pribaltiiskii Ekonomicheskii Raion (The Baltic Economic Region) (Moscow: Nauka, 1970), pp. 87,150 and Ya. G. Saushkin and T. M. Kalishnikova, "Basic Economic Regions of the USSR," in George J. Demko and Roland J. Fuchs (eds.), Geographical Perspectives in the Soviet Union (Colombus: Ohio State University Press, 1974), pp. 164-165, and Alexander Woroniak, "Regional Aspects of Soviet Planning and Industrial Organization," in Bandera and Melnyk, The Soviet Economy, p. 274.

that a policy to make consumer goods more available in other locales would not necessarily lead to higher priority for Central Asian textiles.[8]

Note also that the agricultural growth rate is lagged in the Baltic model. Neither current agricultural growth in the Baltic nor lagged growth in Central Asia was much help in explaining growth in the non-agricultural sectors. One possible explanation for this is the greater importance of meat and dairy products processing in the Baltic. One would expect a lag in the relationship between output in agriculture and output in those industries; indeed, in the short run distress slaughter could even mean an increase in meat processing.

The above are estimates of the Cobb-Douglas version of the model. The alternatives presented in equations (1.2) and (1.3), derived from a CES function and a VES function, respectively, both differ from the Cobb-Douglas by the addition of a single term to the estimating form. Therefore, a useful test of either alternative against Cobb-Douglas is the F test for the relevance of an additional explanatory variable. Choice between the CES and VES forms can be made based on R^2 and standard error.

Initially, the three alternatives were evaluated using

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[8]E. A. Afanas'evskii, Legkaia promyshlennost': ekonomicheskie problemy razmeshcheniia (Light industry: economic problems of location) (Moscow: Mysl', 1976), cited by Leslie Dienes, "Regional Economic Development," a paper presented at the Conference on the Soviet Economy Towards the Year 200. Airlie House, Virginia, October 23-25, 1980.

equation (1) and assuming $r_t=r$, a constant. In most cases, based on republic level data, the VES version was superior to the CES version, and the VES added a statistically significant amount of explanation to the equation. However, for all republics but Lithuania and Kirgizia the assumption of a constant rate of productivity growth led to very poor fits using the Cobb-Douglas form. Addition of the appropriately lagged agricultural growth rate improved the fit for the Cobb-Douglas version considerably, the most extreme example being the single republic fit for Uzbekistan, where the R^2 jumped from roughly .20 to .40 with the addition of the agricultural growth variable.[6] Further, the test for appropriate functional form gave far different results for equation (1.1.a). Specifically, neither the CES nor the VES parent functional form performed significantly better than the Cobb-Douglas parent form. Hence, for the purposes of this study, the Cobb-Douglas equation is judged the appropriate form.

Combining equations (1.1) and (1.1b) gives

$$(1.1.b)\quad q_t = (\beta_0 + \beta_1 qa_t + \beta_2 a_t) + \alpha_1 k_t + \alpha_2 l_t + \varepsilon_{q,t}.$$

The precise parametric values for the computation of A_t were a priori uncertain.[7] Accordingly, nine combinations were

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[6] One possible explanation of this is the importance of cotton processing in the Uzbek economy.

[7] See appendix C for a discussion of functional form and the interpretation choice of function form brings to A_t.

tried, to enable a search over what seemed reasonable values for the exponent on both inter-regional and intra-regional distance. For both regions, the best results were for an exponent of one on both intra-regional and inter-regional distance components. The results given below are for these exponent values.

There are some aspects of the data that are particularly relevant for assessing the results for these equations. As noted above in Chapter II and below in Appendix C, A_t is only defined on an aggregate-region basis. Accordingly, data for the estimation of equation (1.1.b) are created by adding the appropriate data from each republic to generate a regional sum. Since this takes equation (1.1.b) outside the framework of the pooled data set, it has been estimated by means of ordinary least squares. Further, the Baltic as a region is defined to include Kaliningrad Oblast of the RSFSR, which is not included for want of data. Since there is only one large city in Kaliningrad Oblast, this omission is probably not very distortive. For Central Asia, there is insufficient data to allow inclusion of Turkmenia; this omission could produce appreciable distortion, since A_t is defined on a substantially different geographic space than the other variables in the equation. There is not much remedy for this, barring publication of a more complete series for Turkmenia.

The results of equation (1.1.b) for Central Asia are

As computed here, it is a measure of inter-regional draw.

$$q_t = \underset{(.049)}{.022} + \underset{(.572)}{.646}\, k_t + \underset{(.598)}{.199}\, l_t + \underset{(.132)}{.321}\, qa_t$$

$$- \underset{(.784)}{.868}\, a_t{\cdot}D70_t - \underset{(.593)}{.388}\, a_t{\cdot}D5865_t - \underset{(.482)}{.452}\, a_t$$

R^2=.51848 SE=.02991 N=15

and for the Baltic,

$$q_t = \underset{(.048)}{-.013} - \underset{(.807)}{.098}\, k_t + \underset{(1.19)}{2.80}\, l_t + \underset{(.072)}{.0007}\, qa_{t-1}$$

$$- \underset{(.022)}{.018}\, D6769_t - \underset{(.00003)}{.00006}\, a_t{\cdot}D70_t$$

$$- \underset{(1.21)}{2.93}\, a_t{\cdot}D5865_t + \underset{(.712)}{1.83}\, a_t$$

R^2=.84608 SE=.01427 N=16,

where $D70_t$ is a dummy variable having a value of one for 1970 and a zero otherwise and $D5865_t$ is a dummy having a value of one for 1958 through 1965 and a zero otherwise. The reasons for differentiating the coefficient on a_t by means of $D70_t$ and $D5865_t$ were originally technical. The computation of A_t gives a sudden upward jump in the series for 1970, due to the underestimation of city populations during the inter-censal period, followed by suddenly higher figures due to the 1970 census. To remove the effects of this false "jump" in the value of a_t, $D70_t$ is introduced into the model. The graph of Soviet inter-regional connectivity is different for 1965 and prior years than for subsequent years; accordingly, A_t (and consequently a_t) is

not calculated on the same weighting basis for 1965 and prior years as it is subsequently. Therefore, $D5865_t$ is introduced to to accommodate the split in the data series (the equation was also estimated without these variables, with poor results).

Estimation of equation (1.1.a) using ordinary least squares and regional-aggregated data gives*

$$q_t = \underset{(.045)}{.023} + \underset{(.439)}{.623}\, k_t - \underset{(.483)}{.228}\, l_t + \underset{(.087)}{.173}\, qa_t$$

R^2=.34281 SE=.02979 N=15

for Central Asia, and

$$q_t = \underset{(.061)}{-.015} + \underset{(.909)}{1.11}\, k_t - \underset{(.778)}{.029}\, l_t + \underset{(.061)}{.119}\, qa_{t-1} + \underset{(.018)}{.025}\, D6769_t$$

R^2=.58861 SE=.01990 N=16

for the Baltic.

The question involved in this line of enquiry is to determine the relationship between growth of agglomerative potential and growth of output. It has already been argued that economies (or diseconomies for backward regions) of agglomeration are external to individual enterprises. These

*The data for Uzbekistan tend to dominate the series for Central Asia, due to the much greater economic size of that republic. The Baltic republics, on the other hand, are closer to the same size.

economies are of two types: expanded opportunities for specialization; and organizational advantages, some of which are peculiar to the Soviet economy. Interpretation of the results is with regard to the role of agglomerative potential in productivity increases is made difficult by poor fit in the aggregate version of equation (1.1.a), and the high degree of colinearity between l_t and k_t on the one hand, and a_t on the other.

The incremental contribution to fit generated by adding the variables for agglomerative potential is not statistically significant for either region, as determined by the F-test for relevance of additional explanatory variables. This is reinforced by the small t-ratios in the Central Asia case. However, for the Baltic, the t-ratios reveal that the coefficient on a_t is statistically greater than zero for the period 1966-1977, and that for 1961-1965, the value of $\partial q_t/\partial a_t$ is numerically negative but not statistically different form zero.

The statistical results, combined with the dramatic differences in the coefficients on l_t and k_t between equations (1.1.a) and (1.1.b) for the Baltic suggest that in that region growth in agglomerative potential is in fact related to growth of the value of output; the argument is that the F-test is misleading due to multicolinearity. For the post-Khrushchev period, the relationship is as expected. That is, growth in agglomerative potential seems positively related to productivity increases. The rationale for

allowing separate coefficients on a_t for the 1961-1965 period was technical (see the discussion in Chapter II and in Appendix C). The period differences in the Baltic, however, suggest more than a merely technical difference.

Analysis of growth by five-year plan period, using the method described in Chapter V and the results of equation (1), reveals that growth of productivity was lower in the seventh plan period (1961-1965) than was generally the case. The fact that a negative coefficient on a_t turns up for the 1961-1965 period suggests that some change occurring around 1965 and related to interregional economic relations could have been responsible. The most obvious candidate is the change-over from Khrushchev's Sovnarkhoz system to the ministerial system reinstated by Brezhnev. In fact, Brezhnev explicitly criticized the Sovnarkhoz arrangement precisely because, as he put it, economic efficiency was neglected by favoring intra-regional over inter-regional ties.'

The change in the coefficients on k_t and l_t, caused by adding a_t to the model, is difficult to explain, economically. Obviously, the growth (at least in the Baltic) of agglomerative potential is highly correlated with the growth of both capital and labor. This may mean that the growth of capital aside from the growth associated with urban growth is not a contributor to growth (i. e., the

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'Paul R. Gregory and Robert C. Stuart, Soviet Economic Structure and Performance (New York: Harper and Row, 1974), pp. 122-123.

location of capital is as important as the amount, so far as growth of the value of material output is concerned). For labor, the results for the Baltic suggest that growth of labor not associated with a growth of urban concentration has a particularly large impact. This sort of labor growth could be, for example, increases in employment out of existing urban population.

The negative coefficient on a_t in Central Asia, for all periods, deserves some comment, even though the value is not statistically different from zero. This result is not really surprising, when one reflects on the fact that the growth of A_t is a product in a large part of the growth of urban concentration in regions outside of Central Asia. These regions are either industrially developed European areas (the Donets-Dnepr region of the Ukraine, for example), or regions engaged in producing products for trade with those regions (Kazakhstan, for example). Growth of these regions is more apt to stimulate more developed regions of the Soviet Union, because development of the economy proceeds faster in the European regions. Studies of transportation linkages in the USSR show that on the whole, commodities flow from the non-European areas to the European areas, as opposed to between the non-European areas.

The upshot is that the growth of agglomerative potential is apt to in fact work against Central Asia, due to the growth priority and the fact that productivity is lower in Central Asia than in the developed regions, or at

least was during the period of this study. This point of view is generally consistent with the growth patterns observed in market economies at similar levels of development.[10]

The last growth relationship to consider is the combination for equation (1) and (1.a.3), which yields

$$(1.3) \quad q_t = (\beta_0 + \beta_1 qa_t + \beta_2 knp_t + \beta_3 gkf_{t-1} + \beta_4 ls_t) + \alpha_1 k_t + \alpha_2 l_t + \varepsilon_{q,t}.$$

Estimation of this equation (using pooled data and IV procedures) indicated that the growth of the non-productive capital stock, the growth in new capital, and growth in the educated (skilled) work force were all irrelevant (in the statistical sense) in explaining the growth of non-agricultural output for either region.

For growth of NMP in agriculture, equation (2.1) combined with equation (2.1a) gives

$$(2.1.a) \quad qa_t = (\delta_0 + \delta_1 fert\%_t + \delta_2 irri\%_t) + \gamma_1 RAINDIF_t + \gamma_2 TEMPDIF_t + \gamma_3 ka_t + \gamma_4 la_t + \gamma_5 tr_t. + \varepsilon_{qa,t}.$$

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[10]See Felix Paukert, "Income Distribution at Different Levels of Development: A Survey of Evidence," International Labour Review 108 (August-September 1973): 97-126, and Jeffery G. Williamson, "Regional Inequality and the Process of National Development: A Description of the Patterns," Economic Development and Cultural Change 13 (July 1965, Part II), pp. 3-82.

Estimation for Central Asia, using only the data for Uzbekistan and Kirgizia, gives

$$qa_t = \underset{(.083)}{.031} + \underset{(.227)}{.128}\ fert\%_t + \underset{(1.03)}{.121}\ irri_t + \underset{(.0002)}{.0002}\ RAINDIF_t + \underset{(.005)}{.003}\ TEMPDIF_t - \underset{(.888)}{.591}\ ka_t + \underset{(1.08)}{1.85}\ la_t + \underset{(1.09)}{1.55}\ tr_t$$

R^2=.28228 SE=.08777 DW=2.8556 N=32

and for the Baltic the results are

$$qa_t = \underset{(.039)}{.040} + \underset{(.028)}{.057}\ fert\%_t - \underset{(.0002)}{.0007}\ RAINDIF_t + \underset{(.00004)}{.00004}\ TEMPDIF_t - \underset{(.471)}{.726}\ ka_t + \underset{(.618}{.855}\ la_t - \underset{(.842)}{.085}\ tr_t + \underset{(.035)}{.061}\ D6769_t$$

R^2=.35888 SE=.09085 DW=2.3474 N=51.

These results included all the republics in the Baltic; there did not seem to be as much damage to the estimation caused by including Latvia. The poor quality of the fit may be one reason for this.

Fitting the growth equation in agriculture gives extremely poor results, even after very considerable effort. Accordingly, the analysis of output in that sector must be left at the remarks above in Chapter III and some general observations in Chapter V. The results of the above

estimations did, however, suggest the inclusion of $RAIN_t$ attempts to fit equation (2) for the Baltic.

Estimation of equation (7), rural-urban migration, gives

$$[\Delta POPU_t - (PGR_{t-1}/1000)\cdot POPU_{t-1}] = \underset{(17.2)}{-28.1} \underset{(.005)}{-.002}\, POPR_{t-1} \underset{(.0002)}{+.00002}\, POPR_{t-1}\cdot T50_{t-1} \underset{(43.1)}{+61.7}\,(W_{t-1} - WA_{t-1})/W_{t-1} \underset{(5.47)}{+21.4}\,\Delta HU_t \underset{(.025)}{-.022}\, AGCYC_{t-1} \underset{(.286)}{+.264}\, M_{t-1}$$

R^2=.67820 SE=17.865 DW=1.1654 N=50

for Central Asia, and

$$[\Delta POPU_t - (PGR_{t-1}/1000)\cdot POPU_{t-1}] = \underset{(2.54)}{-5.40} \underset{(.008)}{+.005}\, POPR_{t-1} \underset{(.0004)}{+.0002}\, POPR_{t-1}\cdot T50_{t-1} \underset{(11.2)}{+16.0}\,(W_{t-1} - WA_{t-1})/W_{t-1} \underset{(6.95)}{+24.2}\,\Delta HU_t \underset{(.114)}{+.016}\, AGCYC_{t-1} \underset{(.153)}{+.220}\, M_{t-1}$$

R^2=.85650 SE=4.5568 DW=1.7448 N=50

for the Baltic.

Interpretation of these results is made difficult by the effects of multicolinearity; slightly different versions of equation (7) produced different signs on some of the

variables (notably the wage difference), and differences in the t-ratios of considerable magnitude. Neglect of the private sector must take its toll in the wage term, as well as the substantial amount of estimation in the wage variables. Perhaps the reason for the weak t-ratios associated with the wage term in both equations is that other factors--most notably the availability of housing and administrative restrictions on movement--limit migration, even when there is a reserve of people willing to move at the established wage differential.

The most significant and consistent finding is the relationship between urban housing increments and rural to urban migration. The statistical strength and consistency of the coefficient on this variable, for both regions, supports the observations made above in Chapter II. This is not to assert only that urban housing is a "draw" pulling migration. Rather, available urban housing probably also acts to permit forces "pushing" rural dwellers out of agriculture to become operational. That is, housing conditions are a crucial factor in the decisions of rural inhabitants to move to the cities, and therefore a very powerful controlling mechanism for the implementation of governmental policies. It is also likely that official permission to move to the city is related to housing construction. Further, if Soviet cities are labor-short, and the rural population is larger than one would expect for a nation as developed as the Soviet Union, then this finding

strengthens the argument that under-urbanization is a major cause of Soviet labor shortages in the non-agricultural sectors[11] The labor shortages observed in Central Asian cities may be the result of failure to provide adequate housing for potential migrant families.

Estimation of the equations for the non-agricultural labor supply, equation (9), gives

$$L_t = \underset{(57.6)}{438.2} + \underset{(.011)}{.277}\ POPU_t + \underset{(.0005)}{.002}\ POPU_t{}^{*}T50_t + \underset{(.281)}{.342}\ W_t - \underset{(1.60)}{16.1}\ PGR_t$$

R^2=.99732 SE=27.001 DW=1.3742 N=52

for Central Asia, and

$$L_t = \underset{(186.4)}{-206.6} + \underset{(.129)}{.825}\ POPU_t - \underset{(.004)}{.012}\ POPU_t{}^{*}T50_t + \underset{(.882)}{1.02}\ W_t - \underset{(1.51)}{.281}\ PGR_t$$

R^2=.92041 SE=5.3731 DW=2.2146 N=49

for the Baltic. Because of a remarkably low value for the Durbin-Watson statistic (.1355), the equation for the Baltic reflects an estimation procedure to correct for the effects of serial correlation.

The substantial (and statistically significant) finding

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[11]See Roland J. Fuches and George J Demko, "Geographic Inequality Under Socialism," Association of American Geographers, Annals 69 (June, 1979), p. 315.

is the difference between the marginal participation rate in the two regions. This is probably due partly to cultural differerces, such as the reluctance of Turkic women to work outside the home,[12] and partly to the younger population and resultant larger dependency burden. Interestingly enough, there is a significant, negative time-trend in the Baltic propensity to participate in the work force, but there is a significant, positive trend for Central Asia. This may be because Slavic migrants make up an increasing portion of the Central Asian urban population, or because the attitudes of the native urban population are slowly changing, or both. On the other hand, the Baltic population is aging and therefore an increasing portion of the population is made up of retirees.

As in many demographic and labor relationships in this model, the wage turns out to be statistically weak, though with the expected sign. One possible reason for this is the fact that the relevant real wage is not available through the official published data; see Appendix A for discussion. Also, the actual availability of goods, rather than money wages or prices, may be one of the real incentives to work.

The sign (and statistical significance for Central Asia) of the estimate of η_4 (PGR_t) are as expected. The interpretation here is that when the population growth rate

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[12]See Stephen Rapawy, "Regional Employment Trends in the USSR: 1950 to 1975," in Joint Economic Committee, 96th Congress, 1st Session, Soviet Economy in a Time of Change, vol.1 (Washington, D. C.: Government Printing Office, 1979), pp. 602, 611.

is high, so is the dependency burden. Other things equal, higher dependency burdens imply a smaller work force, since more able-bodied adults are required to look after children. One possible reason for the statistical weakness of the result for the Baltic is that the demographic transition (a substantial reduction in birth rates) in that region occurred before the beginning of the study period, and subsequent declines in birth rates have been matched by increases in the number of retirees.

The results for equation (11), the agricultural labor supply, are

$$LA_t = \underset{(43.1)}{-3.85} + \underset{(.005)}{.231}\ POPR_t - \underset{(.0002)}{.001}\ POPR_t{*}T50_t - \underset{(.246)}{.994}\ WA_t + \underset{(1.31)}{1.59}\ PGR_t$$

R^2=.99850 SE=21.248 DW=.5183 N=52

for Central Asia, and

$$LA_t = \underset{(6.36)}{8.57} + \underset{(.001)}{.305}\ POPR_t - \underset{(.0005)}{.0007}\ POPR_t{*}T50_t - \underset{(.052)}{.185}\ WA_t - \underset{(.768)}{2.24}\ PGR_t$$

R^2=.99733 SE=7.1921 DW=1.0211 N=52

for the Baltic. The coefficient on the wage rate behaves "unexpectedly," being statistically significant with a perverse sign. The reason for this, in all likelihood, is

an omitted variable problem. To begin with, effective wage opportunities in the private sector are excluded from this model. Since work in the private sector of agriculture is a substitute for work in the socialized sector, if earning opportunities from private plots are correlated with socialized sector wages, the omission of private sector data will contribute to the above result.[13] Further, increased work opportunities outside of agriculture will have the same effect. Finally, two "social" variables are likely quite important, and also difficult to quantify. First, in Central Asia a surplus labor situation is emerging, due both to demographic and cultural influences.[14] Second, in the Baltic the rural population is aging. Both these changes are positively correlated with the wage rates. In addition, part of the problem may lie in the imprecision of the "average annual worker" definition in agriculture.

As was the case for equation (9), there is a substantial difference (and a statistically significant difference) between participation rates. The Baltic again

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[13]See Clark J. Chandler, "The Effects of the Private Sector on the Labor Behavior of Soviet Collective Farmers" (Ph. D. dissertation, the University of Michigan, 1978), Chapter IV. It is interesting to note that Chandler's study also turned up some perverse signs in the econometric estimation of agricultural labor supply.

[14]S. Enders Wimbush and Dmitry Ponomareff, Alternatives for Mobilizing Soviet Central Asian Labor: Outmigration and Regional Development (Santa Monica: The RAND Corp., R-2476-AF, 1979), pp. 1-5 and Murray Feshbach, "Prospects for Outmigration from Central Asia and Kazakhstan in the Next Decade," in Joint Economic Committee, Soviet Economy in a Time of Change, vol. 1, p. 658.

has the higher rate, though with some evidence of a downward trend. The trend is probably due to the fact that the Baltic rural population is aging, and is therefore made up more of retirees and semi-retirees. In a good part, this is due to the heavy rural-urban migration in the post-World War II period; Table A.18 demonstrates the decline in rural population in the Baltic. That the participation rate is also declining in Central Asia is a most interesting and expected result. When coupled with the statistical insignificance for PGR_t, this seems to substantiate the observations of both Soviet and Western writers that there are increasing numbers of underemployed and unemployed people in Central Asian rural areas.[118] These people do not migrate to cities within the region or to other regions (see the discussion accompanying the estimation results for equation [7] above). This also is consistent with the speculation in Chapter III that VMP_{LA} is low in Central Asia.

Capital Formation.

The principal question to be explored in estimating the relationship between investment and net capital formation is whether or not the investment costs of forming a given

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[118]By aggregating the data in Tables A.18 and A.22, one can show that the portion of the rural population employed in agriculture in the three Central Asian republics declined from 23 per cent in 1960 to 18 per cent in 1976. The absolute difference between rural population and employment in agriculture in Central Asia increased from 6.2 million people in 1960 to 10.5 million people in 1976.

amount of capital are greater in one region than in another. The specific hypothesis is that the investment costs of capital formation are greater in Central Asia, due to working conditions and especially to less skilled labor.[16]

A number of methods were attempted to estimate the rate of physical withdrawal (retirement) of capital in the non-agricultural sectors. These included unconstrained estimation, stochastically constrained (mixed) estimation, and finally non-stochastic imposition of a value taken from the SOVMOD I results.[17] For the latter, a weighted average of national withdrawal rates was used, based on rates estimated for industry, transportation and communications, construction, and the trade and miscellaneous branch. Weights were based on the sector composition of non-agricultural productive-sphere capital on 1 Jan. 1968, the mid-year of the study period.

Estimation of equation (14) using non-stochastically imposed values for the withdrawal rate (rates estimated by the above-described methods are .042 for Central Asia and .04 for the Baltic) gives

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[16]Ann Sheehy, "Some Aspects of Regional Development in Central Asia," Slavic Review 31 (September 1972), p. 558, and E. K. Afanas'evskii, Legkaia promyshlennost': ekonomicheskie problemy razmescheniia (Light industry: economic problems of distribution) (Moscow: Mysl', 1976), pp. 118, 154-159, cited by Leslie Dienes, "Regional Economic Development," a paper presented at the Conference on the Soviet Economy Toward the Year 2000, Airlie House, Virginia, 23-25 October, 1980.

[17]Green and Higgins, SOVMOD I, pp. 215-217.

$$K_t - .958\ K_{t-1} = \underset{(.370)}{.363}\ I_{t-1} + \underset{(.565)}{.015}\ I_{t-2} + \underset{(.380)}{1.01}\ I_{t-3}$$

R^2=.97407 SE=79.734 DW=1.2429 N=49.

for Central Asia, and

$$K_t - .96\ K_{t-1} = \underset{(.225)}{.615}\ I_{t-1} + \underset{(.319)}{.170}\ I_{t-2} + \underset{(.251)}{.672}\ I_{t-3}$$

R^2=.95543 SE=32.077 DW=1.8027 N=47

for the Baltic. Estimation was by OLS, chosen because use of an IV procedure in this data set would lead to the loss of six observations for each region, due to the fact that the available investment series is longer than the series available to construct instruments. Since all the investment terms are lagged, simultaneity bias is only a problem in the presence of serial correlation (therefore the estimate of the equation for for Central Asia is apt to contain some error).

The results can be interpreted from two viewpoints: explaining capital formation, given investment; and evaluating the contention that the investment costs of forming a given amount of effective capital are greater in Central Asia than in the Baltic. Regarding the latter, the

sum of coefficients on the investment terms is a measure of the cost of investment. The higher the sum, the less the investment "wasted," and therefore the lower the investment cost of capital. The sum of all coefficients on investment is slightly greater in the Baltic than in Central Asia, and considering only coefficients that are statistically different from zero, the difference is about 20 per cent. Further, the relative weights indicate that gestation periods tend to be longer in Central Asia.

However, the results are far from satisfactory, from both a statistical and a theoretic point of view. A number of alternatives gave similar results; that is, the sum of coefficients on the investment lag exceeds one, the lag tends to be V-shaped, and some of the coefficients in the lag structure are statistically insignificant. Invariably, the sum of coefficients in the lag structure was larger for the Baltic than for Central Asia. However, the results do not make sense in terms of explaining capital formation given investment, and therefore cannot provide a definitive answer to the issue of regional cost differences in capital formation.

There are three problems with the investment series used in estimating equation (14) that contribute to the poor results. First, the investment data do not include investment by collective farms in non-agricultural activities. This is because data on non-agricultural investment by collective farms are not available, and

experimentation during the course of compiling the data used here failed to turn up a satisfactory method for estimating it. On the whole, the contributions from this source are not large, generally amounting to four per cent or less; the largest amount found in this study was for Latvia in 1977, when non-agricultural investment by collective farms amounted to slightly over five per cent. There is some evidence based on fragmentary data from republic statistical handbooks that in Uzbekistan investment by collective farms amounted to a smaller portion of total non-agricultural investment than in Latvia, being slightly more than two percent in 1977.

Second, some "investment and construction-installation work" included in Soviet total investment is not attributed to any specific republic. The amount of this investment is miniscule.[16]

Third, and perhaps most important, assets retired from use in one enterprise or ministry are sometimes transferred to another enterprise or ministry. These transfers are not included in published investment statistics,[17] but the value of the assets, at the original delivery price, is entered as a liability on the books of the receiving firm. While the firm also receives a partial offset in its books, equal to the accrued depreciation on the assets so received, the

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[16]NARKHOZ 1977, p. 359.

[17]A. Shneiderov, "Vosproizvodstvennye proportsii kapital'nykh vlozhenii" (Reproduced proportions of capital investments), Voprosy ekonomiki (August 1975), p. 28.

result is to inflate gross capital accounts. Gross capital series make up the capital stock values published in official sources.[20]

The regional implications are that regions characterized by low-priority old-technology industries could be expected to receive such transfers (and therefore have the capital stock augmented above what gains are attributable to new investment), and regions characterized by high-priority, new-technology industries would tend to be sources of such transfers. Therefore one could reasonably expect Central Asia to receive, in proportion to total investment, more of such transfers than the Baltic. Of course, the problem of transfers does not affect estimation of national capital stock formation, except that it tends to prolong the active life of fixed assets and thereby lower the withdrawal rate.

Since econometric estimation of the capital formation process does not yield a satisfactory answer to the question of regional differences in the investment cost of capital formation, an alternative approach has been tried. From the results of SOVMOD I it is known that the gestation period on most investment is three years or less.[21] Based on that fact, a ratio of total investment over a three year period to capital stock changes over the same period can be

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[20]See Stanley H. Cohn, "Soviet Replacement Investment: A Rising Policy Imperative," in Joint Economic Committee, Soviet Economy in a Time of Change, vol. 1, pp. 236-237.

[21]Green and Higgins, SOVMOD I, pp. 215-217.

constructed to test for regional differences in the effectiveness of investment. That ratio is

$$R_t = (K_t - K_{t-3})/(I_{t-1} + I_{t-2} + I_{t-3}).$$

The average ratio, $\bar{R}$, will be larger, the larger is the portion of total investment during the three year period that becomes a part of the capital stock. Stated differently, the higher the value for $\bar{R}$, the fewer investment resources are "wasted" or tied up in projects begun but not finished.

The value of $\bar{R}$ calculated for the Baltic is .94, and the value for Central Asia is .87. The difference, seven percentage points, is statistically different from zero.[22] This indicates that either more investment effort is "wasted" in Central Asia, or that the gestation period is longer there. With a study period as long as the one used here, the effect of longer gestation periods is apt to be small.

There is evidence in the variation of the values of R_t for each regional grouping that there are major projects whose completions seem to take longer than three years. Both Western and Soviet writers have commented on the costliness of tying up large amounts of capital in unfinished projects for substantial periods. This could be

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[22]A bivariate normal distribution was used in testing the hypothesis of a difference in the values of $\bar{R}$. The t-ratio of that test was 3.99.

an additional reason why econometric estimation of the capital formation process gave such poor results. That is, in small republics a large project can inject substantial irregularity into the relationship between investment and capital stock increases. Some substantiation of the proposition that project "lumpiness" contributes to estimation problems in these republics comes from the fact that there was less variation in the values of R_t for Uzbekistan, the largest republic, than for the others.

Some consideration of the likely influence of the investment data deficiencies noted above on the calculation of $\bar{R}$ is in order. Only two seem of consequence: the omission of collective farm investment and the influence of capital transfers. The failure to include collective farm investment will bias the calculated value of R_t upward. The scant evidence available suggests that this effect may be greater on the Baltic. The influence of capital transfers is is also to bias R_t upward, but in this case the effect seems likely to be greater on Central Asia. On the whole, at least qualitatively, the effects are likely to be partially offsetting.

In summary, attempts to econometrically estimate the relationship between investment and capital formation, using a number of different econometric techniques, were unsuccessful. The possible reasons for this lack of success are limitations in the data, and the small size of the republics involved. The latter problem allows the discrete

nature of large projects to disrupt statistical regularity. By comparing net capital formation over a three year period with total investment over the same period, it can be determined that it requires more investment to obtain a given increase in the capital stock in Central Asia than in the Baltic.

Econometric estimation of the capital formation process in agriculture gave much better results. For Central Asia estimation of equation 16 gave

$$KA_t - .95\ KA_{t-1} = \underset{(.013)}{.820}\ (IA_{t-1} + IA_{t-2})/2$$

R^2=.97944 SE=45.810 DW=1.7933 N=49

and for the Baltic estimation results are

$$KA_t - .96\ KA_{t-1} = \underset{(.029)}{.996}\ (IA_{t-1} + IA_{t-2})/2$$

R^2=.88037 SE=40.139 DW=1.2298 N=49

A capital retirement rate of five per cent was the value originally imposed on the equation for both regions.[23] However, the estimated coefficient on the investment term for the Baltic using a .95 rate of capital survival exceeded

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[23] The .05 retirement rate is based on the SOVMOD I findings. See Green and Higgins, SOVMOD I, p. 217.

one by a statistically significant amount, and therefore the equation was re-estimated using a retirement rate of .04. Given the climate differences and the substantial amount of animal husbandry involved in the Baltic, it is reasonable to expect more of agricultural capital to be in structures, which in general will have lower withdrawal rates than machinery.

The above results seem to provide a reasonable picture of agricultural capital formation. They also provide an answer to the question of the relative costliness of capital formation in the two regions. Note that a much larger portion of recent investment actually winds up as part of the actively used capital stock in the Baltic than in Central Asia; the difference is statistically different from zero. The decision to use a lower withdrawal rate for the Baltic is not responsible for the difference; in fact, lowering the (imposed) withdrawal rate lowers the coefficient on the investment term. The conclusion is that, as was the case for the non-agricultural sector, the amount of investment needed to create a given amount of active capital is greater on the average in Central Asia than in the Baltic.

There are several reasons that probably combined to make the results of estimating the capital formation process better for agriculture than for non-agriculture. First, the agricultural sector involves less aggregation than the composite non-agricultural sector, so the process being

described is less heterogenous. Second, there are no missing major components of investment in agriculture, equivalent to kolkhoz investment in non-agriculture. Third, one can speculate that transfers of capital in agriculture are either less important or less disruptive of statistical regularity than in non-agriculture.

Wages.

The basic objective in modeling wages in both sectors is to gain some insight into the relationship between the regional wage structure and the value of the marginal product of labor in the respective sector. Also considered in the modeling process are two major wage reforms that occurred during the study period: the 1965 reform of agricultural wages, which essentially placed collective farmers on the same footing as state farm workers; and the 1967 reform of wages in the state sector, which, while it did affect state farms, had its strongest influence on the non-agricultural wage. The results of estimating equation (19) are

$$W_t = \underset{(87.9)}{63.6} + \underset{(36.3)}{164.6}\ D6877_t + \underset{(.040)}{.476}\ VMPL_t$$

R^2=.94381 SE=6.0217 DW=.8910 N=51

for Central Asia and

$$W_t = \underset{(65.3)}{486.2} + \underset{(51.7)}{162.5}\ D6877_t + \underset{(.028)}{.289}\ VMPL_t$$

R^2=.92813 SE=8.1071 DW=.2678 N=52

for the Baltic. For this equation, wages were converted to an annual basis to secure units of measurement comparability.

Interpretation is quite straight-forward. The most important result is that $\partial W/\partial VMP_L$ is much higher for Central Asia than for the Baltic. That is, during the course of the study period the difference between the VMP_L and the wage rose faster in the Baltic than in Central Asia. Therefore, to the extent that labor costs figure in Soviet investment location decisions, ministries would prefer the Baltic to Central Asia more at the end than at the beginning of the period, other considerations being equal. Table III.1 gives the difference between the VMP_L and the wage for the beginning and the end of the study period, by study sample republic.

The shift in wages due to the wage reform of 1967 (which first had full effect in 1968) was very similar for each republic group. Estimation allowing for both "slope" and "intercept" changes in 1968 revealed that $\partial W/\partial VMP_L$ did not change a significant amount with the wage reform.

Efforts to relate agricultural wages to the average product of labor in agriculture measured in comparable

TABLE IV.1

VMP_L-WAGE DIFFERENCE
NON-AGRICULTURE
(Rubles)

Year	The Baltic			Central Asia		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1960	989	974	793	1051	882	779
1977	2461	3046	2345	1603	a1208	a1361

a. Value for 1976.

Sources: Tables for Q, L, and W in Appendix A, results of estimating equation (1).

rubles were completely unsuccessful. In part, this was due to the data deficiencies already lamented above. On the whole, the problem in explaining WA_t by means of the comparable ruble average product of labor in agriculture ($APLA_t$) may be more one of mis-specification. Soviet wages for collective farmers are paid out of farm earnings, and indeed wage reforms in agriculture have been accompanied by procurement price changes.[24] In practice state farm wages and collective farm wages seem to move together; indeed, one of the effects of the 1966 reform was to put collective farmers on the same sort of guaranteed wage as state farm

[24]Vladimir Treml argues that the main reason for agricultural subsidies has been to create an incentive for greater productivity in agriculture. See U. S. Department of Commerce, Bureau of the Census, Agricultural Subsidies in the Soviet Union, by Vladimir Treml, Foreign Economic Report No. 15 (Washington, D. C.: Government Printing Office,

employees. Accordingly, the appropriate relationship is between WA_t and $APLA_t$ measured in current rubles.[23]

Estimation of equation (20), using current ruble output measures and OLS gives[24]

$$WA_t = \underset{(67.5)}{277.6} - \underset{(34.8)}{148.5}\ D5865_t + \underset{(.030)}{.355}\ APLA_t$$

R^2=.92033 SE=77.336 DW=.5889 N=53

for Central Asia, and

$$WA_t = \underset{(80.6)}{-164.0} - \underset{(51.8)}{40.5}\ D5865_t + \underset{(.020)}{.386}\ APLA_t$$

R^2=.94980 SE=114.63 DW=.6112 N=54

for the Baltic. As for estimation of W_t, wages were converted to an annual basis for units comparability.

The significant relationship between current ruble output per worker and wages in the agricultural sector, and

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1978), p. 4.

[23]The average product of labor was used in lieu of the value of the marginal product because of the poor results from attempts to estimate the elasticity of agricultural output with respect to labor, and also because such a estimate would properly relate to comparable, not current, ruble relationships.

[24]Use of OLS is because use of current-ruble value-added in agriculture takes the equation outside the formal model specified above.

the almost complete irrelevance of comparable-ruble output per worker, suggest that there is indeed a close relationship between procurement pricing in agriculture and the wage, calculated as the average of sovkhoz and kolkhoz wages. Further, the similarity of the coefficient on $APLA_t$ for the two regions is worth noting, as well as the fact that for both regions it is fairly small. Note also that the geometry of the equations implies that the wage bill as a share of output was rising for the Baltic, and falling for Central Asia during the study period.[27] Finally, the numerically much larger (and statistically significant) shift for the reform period for Central Asia, and the smaller and statistically insignificant shift for the Baltic imply that most of the effects of the wage reform were carried in the procurement price changes in the Baltic, but the wage reforms implied distributional shifts as well for Central Asia.

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[27]This is demonstrated by the fact that the intercept is positive for Central Asia, and negative for the Baltic.

CHAPTER V

CONCLUSIONS

This chapter contains two sections. The first is a summary and evaluation of the more important findings of the study and the conclusions that they suggest. The second contains recommendations for further study. On the whole, these consist of questions that arose in the course of this work, but were not pursued because they were tangential to it.

Summary and Evaluation.

Appraisal of the results given in Chapters III and IV can be divided into two categories, corresponding to the two principal questions advanced in Chapter I: the causes of differences in growth for the Baltic and Central Asia and the regional impact of Soviet economic policy. Only major points are discussed in this section. Secondary issues will be left at the explanations given above in Chapters III and IV.

Growth and Growth-Related Issues.

The key relationships regarding differences in the sources of growth are equations (1) and (2), and the derived growth equations. Attempts to estimate either the production functions or the related growth equations in agriculture did not yield satisfactory results, on the whole. Accordingly, discussion of the causes of growth in the two regions will be divided into two parts. First, growth in non-agricultural sectors will be analyzed based on the econometric results for equation (1). Then, growth in the agricultural sector will be discussed, on a much more subjective basis owing to the poorer econometric results for that sector.

Growth in the non-agricultural sector can be described using an adaptation of the methods developed by Edward F. Denison.[1] The differences between this work and the methods used by Denison are (1) that he assumed a competitive solution and used factor payments as a measure for the share of income attributable to a given factor, and (2) that he drew on a variety of other works to establish a "consensus" value for the economies of scale prevailing in the countries he discussed. Here, both factor shares and economies of scale are established by means of the parameter estimates from equation (1).

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[1]Edward F. Denison, Why Growth Rates Differ: Postwar Experience in Nine Western Countries (Washington, D.C: The Brookings Institution, 1967), pp. 33-44, 233.

TABLE V.1

SOURCES OF NON-AGRICULTURAL GROWTH BY REPUBLIC
(Average Annual Percentage Rates, 1960-1977)

	The Baltic			Central Asia		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
Average Rate of Growth	10.0	7.9	8.2	9.0	8.6	9.0
Growth Rate due to Factor Growth	7.0	5.0	4.7	7.0	7.4	7.3
Due to Capital Growth	4.2	3.5	3.2	3.4	3.6	3.6
Due to Labor Growth	2.8	1.5	1.5	3.6	3.8	3.7
Growth Rate Due to Productivity Increase	3.0	2.9	3.5	2.0	1.2	1.7
Due to Scale	2.3	1.6	1.5	.1	.1	.1
Due to Factor Productivity	.7	1.3	2.0	1.9	1.1	1.6

Note: The rate of growth due to factor productivity increases is calculated as a residual. The values estimated in equation (1) (the non-agricultural production function) are 1.8 for the Baltic and 1.6 for Central Asia. The input of land is not considered.

TABLE V.2

REGIONAL SOURCES OF NON-AGRICULTURAL GROWTH
REGIONAL AGGREGATE VALUES
(Average Annual Percentage Rates)

	The Baltic (a)	Central Asia (b)
Average Rate of Growth	8.8	9.1
Growth Rate Due to Factor Growth	5.7	7.1
Due to Capital Growth	3.7	3.5
Due to Labor Growth	2.0	3.6
Growth Rate Due to Productivity Increase	3.1	2.0
Due to Scale	1.8	.1
Due to Factor Productivity	1.3	1.9

a: 1960-1977 b: 1961-1976

Note: The rate of growth due to factor productivity increases is calculated as a residual. The values estimated in equation (1) (the non-agricultural production function) are 1.8 for the Baltic and 1.6 for Central Asia. The input of land is not considered.

Estimates of the contributions to growth in non-agriculture by growth of factor inputs and productivity increases are presented in Table V.1 by republic, and in Table V.2 by regional aggregates. Growth due to economies of scale is considered a productivity increase. To calculate the contribution to growth made by capital and

labor separately, the average rate of growth over the period for each factor was multiplied by the share of output that that factor accounted for. For labor, the formula was $\bar{l}[\alpha_2/(\alpha_1+\alpha_2)]$, and for capital, the formula was $\bar{k}[\alpha_1/(\alpha_1+\alpha_2)]$, where $\bar{l}$ is the average rate of growth of the labor force over the period, and $\bar{k}$ is the average rate of growth of the capital stock.

Growth due to economies of scale is determined by the formula

$$gsc = (\alpha_1 \cdot \bar{k} + \alpha_2 \cdot \bar{l}) - \{\bar{l}[\alpha_2/(\alpha_1+\alpha_2)] + \bar{k}[\alpha_1/(\alpha_1+\alpha_2)]\}$$

where gsc is the average rate of growth over the period attributable to economies of scale. The formula for gsc is based on the definition of economies of scale. If all factors grow by 10 per cent, and output increases by 12 per cent, then 2 per cent of the growth is accounted for by economies of scale. Therefore, gsc is the difference between total growth generated by growth in factor inputs, $\alpha_1 \cdot \bar{k} + \alpha_2 \cdot \bar{l}$, and the growth that the same factor input growth would have generated under constant returns to scale, $\{\bar{l}\{\alpha_2/(\alpha_1+\alpha_2)]+\bar{k}[\alpha_1/(\alpha_1+\alpha_2)]\}$. The terms in brackets, [·], in the second expression serve to scale proportionately the output elasticities of capital and labor to values that together are constant-returns-to-scale equivalents. This is analogous to Denison's method, wherein the amount of growth attributed purely to the growth of a given factor

corresponds to the growth of the factor times that factor's share of total income, assuming a competitive solution.[2]

Growth of factor productivity by this method is defined as the residual between the rate of growth over the period in each republic, and the total growth that can be accounted for by growth of the primary factors (including economies of scale). The rate of growth calculated by this method can be compared with the value of Hicks-neutral productivity growth estimated in equation (1) for each region. The difference between the value calculated by the average residual for each region and the estimated value from equation (1) is due to the fact that the residual comes out of a calculation using growth rates between 1960 and 1977 (with exceptions as noted), while the value from equation (1) is an average over the period, based on annual intervals.

From Tables V.1 and V.2 it can be seen that the rates of growth of the two regions were fairly similar; the two extreme values both come from the Baltic. However, the causes of growth were fairly dissimilar. On the whole, capital grew about 32 per cent faster in Central Asia, and the labor force grew 50 per cent faster, than they did in the Baltic. As a result, the rate of growth attributable to productivity increases was 55 per cent greater in the Baltic than in Central Asia; most of this difference is due to differences in the economies of scale. Regarding investment location decisions, returns to scale may be a more relevant

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[2]Ibid., p. 233

datum than VMP_K, since a remarkably large amount of Soviet investment consists of new plant.[3] The results of estimating equation (1.1.b) suggest that in part these may be economies of scale external to the individual firms.

Growth of the capital stock has contributed heavily to the rate of growth in both regions, though the rate of output growth generated by a given rate of growth of the capital stock was higher in the Baltic, due to the much higher capital elasticity of the value of output. Growth of the capital stock during the study period generally was higher in Central Asia than in the Baltic, however.

The sources of growth identified for these two regions form an interesting contrast with the sources of growth Denison identified for Western Europe and the United States from 1950 to 1962.[4] There are several problems in directly comparing the results of this analysis of growth in two Soviet regions with Denison's results for developed capitalist countries. First, and perhaps most important,

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[3]For the USSR as a whole, the range is from 72 to 80 per cent for the years for which values are known (1965, 1970, 1973). This can be compared with percentage values in the mid-fifties for the U. S. in the post-World War II period. See Stanley H. Cohn, "Soviet Replacement Investment: A Rising Policy imperative," in Joint Economic Committee, 96th Congress, 1st Session, Soviet Economy in a Time of Change (Washington, D. C.: Government Printing Office, 1979), vol. 1, pp. 230-231. Other studies have concentrated on the ruble value of the marginal product of capital, and therefore have apparently chosen not to make this interpretation. See, e. g., Leslie Dienes, "Regional Variations of Capital and Labor Productivity in Soviet Industry," Journal of Regional Science 12 (December, 1972), pp. 401-406.

[4]Denison, Why Growth Rates Differ, pp. 298-318.

Denison analyzed the growth of all national income, while the above results cover only the non-agricultural sectors of the material sphere, thus omitting agriculture and the service sectors, which are slower-growing sectors of the Soviet economy. Second, as noted above, Denison used a factor incomes approach along with the assumption of a competitive solution, while econometric analysis is used here. Third, more separate sources of growth were considered in Denison's study than the capital, labor, and productivity increases covered here.

The most apparent difference between the Soviet experiences and the market economy experiences is the much larger portion of growth that can be accounted for by the growth of capital in the Soviet regions, and the much lower portion of growth accounted for by productivity increases in those regions. The portion of Soviet growth explained by growth of the capital stock ranges from 38 per cent in Uzbekistan to 44 per cent in Latvia. The range for the Western countries was from 12 per cent in Italy to 29 per cent in Denmark. Conversely, the portion of Soviet growth accounted for by productivity increases ranged from 14 per cent in Kirgizia to 43 per cent in Estonia. In the market economies the range was from 42 per cent in the United States to 72 per cent in Italy.

The conclusion is that growth in the Soviet regions studied here is more due to extensive growth and less due to intensive growth than was the case in the developed market

economies from 1950 to 1962. While Soviet growth rates were high, they were accompanied by considerable commitment of resources to growth objectives.

The difference between the rates of growth of capital in the two regions would have been greater, had it not been for two regional disparities in the investment-capital formation process. First, for a given increase in the regional "priority share" of investment, the marginal increment to actual investment in the Baltic was 35 per cent more than it was in Central Asia (see the investment section in Chapter III). This suggests that during the study period planners tended to prefer the Baltic as a site for investment projects, probably precisely because of the higher capital elasticity of output. Second, on the average a given amount of investment in the Baltic generated the formation of eight per cent more capital than the same amount of investment in Central Asia (see the capital formation section in Chapter IV). Generally, the difference was greater during the early years of the study period, with some closing of the gap in the last six years (1972-1977) of the period.

Growth in the labor forces during the study period is primarily attributable to changes in the urban population and the marginal participation rate during the period. In Central Asia, the size of the labor force was also related to changes in the population growth rate. Differences between the two regions in the marginal participation rate

ranged from .40 to .20 from 1960 to 1977 (see the labor section in Chapter IV). Increases in the Central Asian rate were slight; most of the narrowing was due to declines in the Baltic marginal participation rate. While the statistical evidence is weak, there is some indication that employment in the Baltic is more sensitive to wage changes than is employment in Central Asia.

In summary, in the non-agricultural sectors NMP in the Baltic and in Central Asia grew at about the same rate over the study period as a whole. However, as can be seen from Tables I.5 and I.6, both capital and labor grew faster in Central Asia than in the Baltic. However, growth due to productivity in the Baltic offset the effects of higher rates of growth of factor inputs in Central Asia. The source of the Baltic's advantage in productivity-generated growth was economies of scale, which were due almost entirely to a much higher (83 per cent larger) elasticity of output with respect to capital. In tables V.1 and V.2 above, the rates of joint factor productivity increase calculated as a residual gave an edge in that department to Central Asia. However, the regression results presented in Chapter III for the production functions [equation (1)] indicate a slightly larger value for the Baltic. On the whole, the evidence is not strong enough for a firm conclusion regarding which region has experienced the higher rate of joint factor productivity growth.

Conclusions regarding agricultural output are more

difficult to draw, due to the weak econometric results. The findings discussed below are offered tentatively, therefore.

The larger (numerically) capital elasticity of QA_t (γ_3) for Central Asia (a fairly consistent result in numerous attempts to estimate alternative versions of the production function and growth equation for agriculture), coupled with the substantially higher (58 per cent greater at the end of the period, in fact) average product of capital in Central Asia suggests that the VMP_{KA} must be greater there.[5] Since it seems plausible that γ_3 is larger for Central Asia than for the Baltic, and further the growth rate of capital was 25 per cent higher in Central Asia during the study period, it seems reasonable to believe that the contribution of capital growth to output growth was greater in Central Asia. Indeed, it may have been the principal contributor there.

The role of labor is more difficult to assess. The average product of agricultural labor is higher in the Baltic than in Central Asia, on the whole. The evidence suggests that the recent stagnation of output in Baltic agriculture is due to the total effect of migration out of rural areas. First, it has reduced the agricultural work force. Second, migrants tend to be young and male, leaving behind older workers and women. Indeed, women make up roughly half of the Baltic agricultural work force.[6] As a

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[5] From the data in Tables A.3 and A.6 one can see that AP_{KA} was 58 per cent larger in Central Asia than in the Baltic at the end of the study period.

[6] U. S. Central Intelligence Agency, USSR Agriculture

result, it seems reasonable to believe the productivity of an agricultural worker may have declined in the Baltic at the same time, everything else being equal.

Another interesting difference between the two regions is in their economic connections with the rest of the Soviet national economy. The relevance of agglomerative potential for the Baltic, and its lack of relevance for Central Asia, suggest that the Baltic is more integrated into the total Soviet economy than is Central Asia (see the growth equations in Chapter IV). In particular, the relevance of growth in agglomerative potential in explaining Baltic growth suggests two conclusions. First, the Baltic is an important source of supply for goods that are its specialties. Second, growth of urban concentration (correlated with growth of industrial production) both within the Baltic and within regions that are its economic partners is therefore a stimulus to economic growth in the Baltic. On the other hand, growth of the Central Asian economy is not aided by the growth of opportunities for interregional economic connections.

It has been observed that the Central Asian rural population has grown, without the tendency toward out-migration that is often observed in poorer regions of other countries. Indeed, the empirical evidence of very low

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Atlas n.p.: n.p., 1974), p. 38, and Paige Bryan, "Large Contingent of Student Labor in the Nonchernozem Zone," Radio Liberty Dispatch RL 224/74 (New York: Radio Liberty Committee, 1974), p. 1.

rural-to-urban migration rates in Central Asia, coupled with the perception that ethnic, cultural, and religious ties tended to hold Central Asians in rural areas and in small towns among their own people, have led scholars to argue against the prospect of substantial migration out of Central Asian rural areas.[7] However, the estimation results for equation (7) suggest that, as in the Baltic, migration from rural to urban areas of Central Asia responded strongly to new housing availability during the period of this study.

One interpretation suggested by the econometric evidence and scholarly observations is that the lack of available housing has discouraged migration. Central Asians who would consider migrating do not do so, because they cannot find suitable housing for their families. This is in part because substantial housing goes to migrants from other (Slavic) parts of the USSR, and in part because apartments in cities offer less dwelling space than is available in the country, while families are larger than the Soviet average (5.82 persons average, in 1970 in Uzbekistan, for example).[8] The conclusion is that Soviet housing construction policies may have been as much the cause of low

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[7]The case against substantial migration out of Central Asian rural areas is made in Feshbach, "Prospects," pp. 656-709. An interesting alternative to tap Central Asian labor reserves by inducing Central Asian rural dwellers to move to labor-short agricultural areas in the European areas, which the results above suggest could be successful, is discussed in Wimbush and Ponomareff, Alternatives, pp. 12-19.

[8]Feshbach, "Prospects," pp. 674-675.

rural-urban migration in Central Asia as ethnic ties.

The labor force participation rate in the urban (non-agricultural) sectors is substantially higher in the Baltic than in Central Asia. The significance of this is that the urbanization costs associated with maintaining a given work force during the study period in the Baltic were therefore likely to be less, since a larger share of the population is workers.

The participation rate is also much higher in the rural (agricultural) population for the Baltic, and the trend in Central Asia is toward lower participation rates. This is confirmation of the existence of a growing pool of surplus labor, noted above; in fact, because of the way the average annual number of workers is calculated, the change in participation may understate the change in surplus labor.'

One very interesting question is whether or not the cost in investment resources to form a ruble's worth of new capital is greater in Central Asia than in the Baltic. For the agricultural sector, there is econometric evidence that this is the case, since the coefficient on the investment lag structure for the Baltic is 21 per cent greater than the same coefficient for Central Asia, and the difference is statistically significant. For non-agricultural capital formation, as noted above, there is evidence (statistically significant) that formation of a given amount of capital requires eight per cent less investment in the Baltic than

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'Ibid., 660-662.

in Central Asia (see the capital formation discussion in Chapter IV). The raw data show that the difference was greater early in the period, and less later in the period.

Government Policies.

Regarding deliberate Soviet policy directed toward the problem of regional economic differences, two questions have been explored. The first is whether or not the Soviets invest to equalize regional development. The second is whether or not the Soviets underwrite consumption in poorer regions by means of public consumption and/or various transfers to households. It is important to note that the nature of the time-series data set allows tests regarding these questions only insofar as they relate to these regions and are consistent over time.

Evaluation of the results for equations (13) and (16) (the investment equations) reveals that there is no statistically significant evidence of development-equalization-related investment in the non-agricultural sectors (see the investment section of Chapter III). However, There is some evidence that economic development per se may have been a real goal of investment in agriculture in both regions during this period.

The evidence from Chapter III regarding state action to equalize consumption is fairly clear. For both regions, there were statistically significant indications that the government acts to reduce inequality in total consumption.

For Central Asia, there is also significant evidence of state support of private (household) consumption based on relative per capita income. The evidence points toward a region-equalizing effect for household consumption in the Baltic, but the statistical results are weak. The total consumption equation for both regions supported the conclusion that state policies reduce differences in consumption, based on relative per capita income (the variable $RDEV_t$). The conclusion is that in general state policies have consistently acted toward reducing inequality in regional consumption.

The influence of non-regional elements of Soviet economic policy are also important in the determination of regional investment. The principal determinant of regional investment in the model (and in reality, most likely) is regional investment priority based on regional economic composition and national sectoral investment decisions. Because of the way this variable is constructed, its entry into equations (13) and (16) allows the coefficient on the defense variable to be interpreted as primarily a locational effect. The results in the investment section of Chapter III suggest that the effect of increases in defense spending during the study period was to reduce investment in non-agriculture by more than could be accounted for, based simply on the sector and branch composition of output for both regions. Further, there was no statistically significant evidence that this pattern changed over the

period. This suggests that Koropeckyj's observations on the regional effects of defense expenditures, based on observations during the sixties, can be extended to include most of the seventies.[10] That is, defense industries seem to be located away from peripheral areas, following the pattern instituted before World War II.

The regional priority approach to predicting the spatial allocation of resources gave quite good results.[11] In the non-agricultural sector, taking into account the influence of defense, relative regional development, and the planning cycle, the marginal effect of a change in regional priority is greater in the Baltic than in Central Asia. That is, given the same sector-based regional investment priorities, investment was greater in the Baltic than in Central Asia. This suggests an effective preference on the part of agencies effectively allocating investment resources for investment in the Baltic during the study period, compared with Central Asia.

The fact that there are no substantial regional differences in wages has been noted in Chapter IV.[12] An

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[10]See Ivan S. Koropeckyj, "Industrial Location Policy in the USSR During the Post War Period," in U.S., Congress, Joint Economic Committee, 91st Congress, 2nd Session, Economic Performance and the Military Burden in the Soviet Union (Washington, D. C.: Government Printing Office, 1970), pp. 262-264.

[11]See the results of estimating equations (13) and (16) in Chapter III.

[12]See Gertrude Schroeder, "Regional Differences in Incomes and Levels of Living in the USSR," in V. N. Bandera and Z. L. Melnyk (eds.), The Soviet Economy in Regional

important objective in modeling wages was to gain information on the potential effects of Soviet wage policy vis-a-vis investment allocation. For the non-agricultural sectors, the evidence is that wages relative to the VMP_L were on the whole higher in Central Asia than in the Baltic, and the difference VMP_L and the wage tended to rise faster in the Baltic than in Central Asia. The conclusion from this is that Soviet wage policy tended, over the period of this study, to make labor costs relatively higher in Central Asia compared to the Baltic. This would lead ministries trying to economize on the wage bill to prefer investments in the Baltic rather than in Central Asia, other things being equal.[13] This likely contributes to the numeric differences between the coefficient on $PRIO_t$ in the Baltic and $PRIO_t$ in Central Asia. Wage policy is also a mechanism whereby household consumption may be equalized.

Wages in agriculture were shown to be closely related to agricultural procurement pricing. The econometric evidence suggested that the wage bill in Baltic agriculture, as a share of current-ruble value added in agriculture, rose during the study period, while the reverse was true for Central Asia.

Finally, the importance of the dummy variable $D6769_t$ in accounting for growth in the Baltic (see the section on

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Perspective (New York: Praeger, 1973), p. 172.

[13]See Alexander Woroniak, "Regional Aspects of Soviet Planning and Industrial Organization," in Bandera and Melnyk, The Soviet Economy, p. 273.

growth equations in Chapter IV) suggests that regional rates of growth can be substantially affected by governmental intervention, aside from the government's influence on the regional availability and employment of primary factors. For example, by influencing the timeliness and completeness of the delivery of material inputs, the state can have an influence on regional growth beyond the influence it has due to its ability to establish the availability and employment of primary factors. The relevance of $D6769_t$ demonstrates the degree to which the actual operation of the economy, compared to the planned operation, is susceptible to the regime's intervention on a priority basis.

In summary, over the period of this study, the Baltic economy was characterized by larger returns on scale in non-agriculture (largely due to a higher capital elasticity of NMP with respect to capital), and was more an integral part of the Soviet economy as a whole than was Central Asia. Further, there is some evidence that the formation of new non-agricultural capital was less costly in the Baltic, and that effective labor costs in the non-agricultural sectors were lower. All of these factors likely combined to make the Baltic a more attractive region to planners for investment in non-agriculture than was Central Asia. The substantially larger coefficient on $PRIO_t$ in the investment equation for the Baltic than for Central Asia suggests that, given a set of investment priorities and taking into account the other factors included in the equation, the planners in

fact did allocate more investment resources in non-agriculture to the Baltic than to Central Asia.

There is little evidence that non-agricultural investment resources have been systematically directed so as to reduce regional differences in per capita income. For agriculture, the evidence from both regions suggests that Soviet investment policy acted toward the reduction of regional inequality in per capita NMP. There is substantial evidence from both regions that over the course of this study period Soviet policies consistently acted to reduce inequality across regions both in public and in total consumption, and some evidence to support the contention that Soviet policy acted to reduce inequality in private (household) consumption.

The findings suggest some general hypotheses about regional inequality in the Soviet economy. To begin with, there seem to be some forces at work that tend to preserve and even exacerbate regional differences in income. As has been suggested for market economies,[14] more prosperous regions of the country tend to offer (at least for a while) better returns on investment than, in general, do poorer regions. This is both because new capacity is itself more

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[14]See Simon Kuznets, "Economic Growth and Inequality," American Economic Review 45 (March, 1955), pp. 1-28; Felix Paukert, "Income Distribution at Different Levels of Development: A Survey of Evidence," International Labour Review 109 (August-September 1973), pp. 97-126; and Jeffery G. Williamson, "Regional Inequality and the Process of National Development:L A Description of the Patterns," Economic Development and Cultural Change 13 (July, 1965, Part II), pp. 3-82.

productive in those regions, and because the investment costs of creating that new capacity are less.

Naturally, planners who pursue output/growth goals will tend to locate more investment projects in the advanced regions than in the poorer ones, everything else being equal. One substantial difference from market economies, however, is that in the USSR migration from the poorer to the richer regions does not seem to occur to the same extent.[15] This may be due to direct controls (e. g., internal passports, residency permits, etc.), housing availability in the advanced regions, cultural and ethnic friction, or all three. One would reasonably expect this to lead to an investment shift toward poorer, labor surplus areas perhaps sooner than would occur with greater migration.

In fact, in August of 1977 Gosplan issued an order to its component units that new project starts be directed away from labor short areas of the European Soviet Union (including the Baltic) and toward labor surplus areas (such as Central Asia).[16] To what extent this will be executed remains to be seen.

The policy of rough wage equality within a branch of the economy and across regions obscures differences in opportunity costs and productivity. In fact, therefore, it may be that a policy of wage equalization acts to perpetuate

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[15]Koropeckyj, "Equalization," p. 59.

[16]Feshbach, "Prospects," p. 665.

existing regional inequalities and retard growth of backward areas by encouraging ministries to locate investment projects in developed regions like the Baltic. Add to this the fact that labor is in fact in short supply in Central Asia in urban areas, where manufacturing enterprises tend to be built, and ministerial preferences become even clearer.

Recommendations for Further Study.

The results of this study are conditional on the values of comparable-ruble net material product used. Unfortunately, there are several questions that remain unanswered concerning the republic-level NMP growth indexes by sector. Further study to determine precisely how these indexes are calculated, and to reconcile the results of individual sector indexes with the aggregate NMP growth index would be of considerable value. Unfortunately, this may have to wait publication of further information in the Soviet Union.

This study was based on only two regions of the USSR. A partial test of some of the generalizations made above could be made by extending the coverage to other regions. In particular, generalizations about the spatial investment effects of defense expenditures, and the specific policies of the Soviet government regarding regional inequality could be so tested. Since the data for such a study are not available for the regions internal to the RSFSR or the

Ukraine, the spatial basis would have to be either the Union republics, or a non-exhaustive set of regions.

One of the major disappointments in the econometric work was the inability to fit adequately the agricultural production and growth equations. The chief difficulties lay in the data available. To begin with, the "average annual workers" measure is far too coarse for useful results in a growth model; the data can conceal substantial changes in the actual expenditure of labor resources. Some alternative, calibrated in man-days, for example, would help considerably. Second, the weather data were inadequate. Some measure that captures catastrophes such as late freezes or incidents of the sukhovei would undoubtedly help. Data on the rainfall at the headwaters of Central Asian rivers, rather than at low-lying cities, would probably give better results in the moisture dimension for Central Asia. A consistent measure for drained area under cultivation in the Baltic would also be of help in fitting the equation for that region. Finally, the biggest barrier to fitting the production function for agriculture is undoubtedly the poor quality of the output measures available (QA_t). Some consistent and reliable measure of value added in the agricultural sector would be a tremendous asset.

The poor data on agricultural wages, both due to the substantial amount of estimation involved and due to exclusion of the private sector, made evaluation of the role played by wage differences in rural-urban migration, and in

determining the agricultural work force, difficult. A time series of total wages and of more accurate socialized sector wages would be quite helpful. Again, however, this pends publication by the Soviet authorities.

In particular, some of the results of this study suggest the relevance of more detailed research into the relationship between the availability of urban housing (and related amenities) and migration. Such research would benefit from a better measure of rural-to-urban migration than that afforded by assuming urban population natural growth rates were the same as the republic average, which tends to understate the extent of migration. This is especially important for Central Asia, where major efforts are currently under way to tap rural labor reserves. The key question in such a line of enquiry would be to ascertain if Soviet urban labor force shortages, particularly in Central Asia, are indeed self-inflicted due to governmental under-investment in the non-productive sphere, particularly in housing.

APPENDICES

APPENDIX A

DEFINITION OF BASIC VARIABLES AND SOURCES OF DATA

For the purposes of this appendix, the basic variables used in the model will be divided into two groups: variables measured in units of value; and variables measured in "natural" or "physical" units. The rationale for this division is that analytic use of data in value units requires a different consideration of exactly what is being measured (and therefore how the analysis is to be interpreted) than data in physical units. Accordingly, this appendix is itself divided into two sections, one for variables measured by value and another for variables measured in physical units.

Before the data set itself is taken up, a few general comments about published Soviet statistics seem in order. The Central Statistical Administration (Tsentral'noe Statisticheskoe Upravlenie, or TsSU) of the USSR Council of Ministers has published an annual statistical handbook since 1958 (a similar publication was also issued for 1956), allowing the construction of some data on a time series basis for the union republics. In addition, subordinate branches of the TsSU in most republics publish handbooks on a more or less regular schedule, giving fairly complete time series coverage of the republic, and with coverage that is similar in many respects to that of the national handbook.

However, there are differences in coverage from republic to republic. These differences include which data are published and in what form, and the regularity with which they have been published. Examples of the first sort of differences include the practice of publishing amortization allowances in some republics but not in others, and differences in the treatment of statistics on national income (natsionalnyi dokhod, or net material product, hereafter abbreviated NMP). A few republics publish NMP in current-year rubles by major sector of the economy (industry; agriculture; transportation; communications; and a composite sector containing the rest of material output, chiefly trade, agricultural procurement, and material supply), and growth indexes for both total NMP and the major sectors of NMP. Some republics publish only NMP growth indexes and current-year ruble sector composition, others routinely publish only the growth statistics for NMP and its constituent sectors, and a few regularly publish aggregate NMP growth statistics, along with current year ruble values for NMP and its component sectors. These differences are discussed below as the data used for individual variables are covered in turn.

The second difference in coverage among the republics is the regularity with which statistical handbooks are offered. While for most republics a volume was printed for 1957, many did not begin routine publication of statistical annuals (often actually put out on a two or three year

basis, but usually with an over-lap of coverage) until 1965. Fortunately, for six of the seven republics in this study, most data can be extended back to 1960 with the use of monographs that have also been published, though for some variables (most notably the wage data) only by estimation. The seventh republic, Turkmenia, has been deleted from the model due to non-availability of data. Data that have been estimated are identified both in the discussion and in the tables below. The particular problems that estimation of parts of the data introduces into fitting the model are discussed in Chapter III and Appendix B, along with the methods used to achieve consistent parameter estimation.

Data in Value Units.

The output measure used in this study is NMP. Soviet statistical sources also give both levels and growth rates for another output measure, aggregate (gross) social product (sovokupnyi [or valovoi] obshchestvennyi produkt). This measure has been rejected both because it involves considerable double counting, and because it is sensitive to the organizational changes that have occurred over time in the Soviet economy, thus making it unreliable as a growth measure.[1] There are two aspects of the NMP concept that

[1] Gross social product is discussed at length in Abraham S. Becker, "National Income Accounting in the USSR," in Vladimir G. Treml and John P. Hardt, eds., Soviet Economic Statistics (Durham: Duke University Press, 1972), pp. 73-74.

have important implications for the analysis here: coverage (or concept) and pricing.

The nearest analog to NMP in western accounting practices is net national product. The major differences are that Soviet practice restricts the concept of production to material product. Production in Soviet accounting practice (following Marxian practice) is the product of social labor in material form. Labor is social if it is reproducible and regularly performed, and a product is material if it involves a physical good. The term physical good is broadly interpreted. Activities that add to the value of material goods, even though they do not themselves create a new physical product, are counted in the sphere of material production. Examples of such activities include freight transportation and retail trade. At times the boundary between material and non-material production is somewhat artificial; for example, passenger transportation is not part of material output, while freight transportation is, or steam generation in a factory is part of material production. while steam generation in public baths is not.[2] Further, due to actual accounting practices (Soviet statisticians compute value of output from the books kept at the enterprise level) the distinctions are often blurred.

Net material product measures are net of depreciation.

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[2]More examples of this sort are in Al'bert L. Vainshtein, Narodnyi dokhod Rossii i SSSR (National income of Russia and the USSR) (Moscow: Nauka, 1969), pp. 18 and 114.

The actual method of computation involves first calculating total transferred value, or GSP, and then deducting from it the value of both material inputs and depreciation. It is therefore newly created value or in Marxian terms, the sum of labor earnings and surplus value.

Contained in the NMP measure is the revenue generated by the state through the mechanism of the turnover tax (T.O. tax, hereafter). This is a tax levied principally on consumer goods and serving two functions: a source of revenue (along with a share of the profits of state enterprises); and a mechanism for bringing the total wage bill and the value of consumer goods into rough balance.[3] The Soviet practice of counting the T.O. tax as part of value added presents no particular problem in the determination of NMP for the USSR as a whole. However, matters are more complicated in the determination of republic NMP.

There are two methods used to allocate turnover tax receipts to republic national income accounts. The TsSU attributes the total T.O. tax collected in an industrial branch to the individual republics, based on the shares of those republics in the total output of the given branch. The Gosplan (the state planning agency) credits to a republic all T.O. tax collected within its borders, regardless of how collected or where the goods were

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[3]See Paul R. Gregory and Robert C. Stuart, Soviet Economic Structure and Performance (New York: Harper and Row, 1974), pp. 140-149.

produced. For some republics, the difference amounts to 25-30 per cent. The data used in this study are taken from TsSU publications, and therefore the national incomes of republics with above-union-average portions of their capital stocks devoted to producing consumer goods (which include those in our study) are likely biased upward.[4] However, since both the Baltic and Central Asian regions have larger than the national shares of output originating in the light and food industries (the actual locus of most of the tax), the relative effects of the distortion are likely to be partly off-setting. Further, changes in the T.O. tax over time are apt to have affected both regions in a similar fashion, for the same reasons.

One remaining question regarding the T.O. tax has implications for this study, namely, the sectoral distribution of NMP. The model used here is disaggregated into two "sectors" of material output, agriculture and non-agriculture. How the tax is allocated by sector has considerable implication for the relative (and absolute) size of the two sectors. Soviet usage appears to be to include the turnover tax in the sector of administrative incidence.[5] Inasmuch as the bulk of T.O. tax receipts come from industrial products (in 1959, approximately 84 per cent of all T.O. taxes were paid from the light and food

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[4]Ivan S. Koropeckyj, "Methodological Problems of Calculating National Income for Soviet Republics," Journal of Regional Science 12 (December, 1972), p. 391.

[5]Becker, "National Income," p. 101.

processing industries),[6] this practice will understate the contribution of agriculture to total value added, and overstate the contribution of the composite non-agricultural sector. The reason is that most of the consumer goods on which the tax is levied are ultimately of agricultural origin.[7]

Output is valued at prevailing prices, which are on the whole determined administratively. Consequently, sector shares of NMP for a given year reflect the vagaries of the price-setting mechanism.[8] The usual pricing practice is to work from general price lists that remain fixed for substantial periods of time, and then undergo major revisions. Further, the timing of these revisions varies from sector to sector, as does the actual method of constructing prices. The major problem injected by this is that failure to update the price system leads to substantial distortion in all the value indicators. As Bond has pointed out the use of Soviet value indicators, coupled with the fact that Soviet managers are not free to minimize costs even subject to the official price lists, gives estimates of

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[6]V. D. Belkin Tseny edinogo urovnia i ekonomicheskie izmereniia na ikh osnove (Prices of a unique level and the economic measurements in their bases) (Moscow: Nauka, 1963), cited by Stanley H. Cohn, "National Income Growth Statistics," in Treml and Hardt, Soviet Economic, pp. 128-129.

[7]Stanley Cohn, "National Income Growth Statistics," in Treml and Hardt, Soviet Economic Statistics, pp. 128-129.

[8]Many western writers are of the opinion that capital goods are undervalued relative to other goods.

econometric models different properties than would be the case in a competitive market economy.'

There are also problems in the inter-temporal comparison of NMP figures that will affect this study. These difficulties will influence the results through both the comparable ruble estimates of the levels of NMP and its component sectors, and through the growth series of the component sectors. In fact, the basis for the computation of the levels and growth rates of value of output used in this study has been the indexes published in various republic handbooks, giving relative comparable-ruble values of aggregate NMP and NMP in five sectors: industry; agriculture; transportation and communications; the construction industry; and a residual sector made up of retail trade, material supply (relating to industrial activities), procurement (relating to state procurement of agricultural goods), and "other material production." Unfortunately, the use of the official growth statistics brings up additional difficulties of two sorts: first, the method of obtaining comparable values over time; and second, the availability of data.

Consider first the properties of the published growth indexes, for the period 1958-1977. For some time western

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'This is because managers are not free to select the input mix that minimizes cost, nor are they free to select those outputs that yield the greatest profit. See Daniel L. Bond, "Multiregional Economic Development in the Soviet Union: 1960-1975" (Ph. D. dissertation, University of North Carolina, 1979), pp. 51-52.

scholars have been concerned with the reliability of Soviet growth statistics, historically due to considerable differences between official growth data and western reconstructions of GNP growth indexes. For the period 1958-1966, Stanley Cohn has evaluated the likely sources of differences between official growth indexes and Western reconstructions of the growth indexes, identifying in particular the relative effects of three sources of divergence.[10] These three sources are differences in coverage, in sector weighting (which covers differences due to the treatment of the T.O. tax), and in sector net output (which includes pricing-induced differences).[11] Since for

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[10]Cohn, "National," pp. 122-137.

[11]There are two well-known price indexing problems worthy of particular mention. First is the "new products" problem, which involves the calculation of price indexes and the incentive prices for the introduction of new products. It appears that the basis of price index calculation is a substantial sample of industrial products taken in 1956 (see Morris Bornstein, "Soviet Price Statistics," in Treml and Hardt, Soviet, pp. 358-359). As time passes, some products leave the product sample and new ones enter. The outcome is an erosion of the product sample. At the same time, price administration practice is to allow premium prices for the introduction of new products, to defray the costs of innovation and as a reward for "progress." One response by Soviet managers has been to claim the new products mark-up for products that contain only frivolous improvements. When these bids for higher prices are accepted, the actual transaction price on what is essentially the same product goes up. As this is now a "new" product, the price increase is not incorporated into the price index, because the "new" good is not a part of the base sample. The second problem has to do with the deflators used in arriving at sectoral comparable ruble values. Albert Vainshtein, Norodnyi dokhod Rossii i SSSR, p. 135 shows that for 1950=100, the price deflator for NMP as a whole implied by the official growth indexes and current-year ruble values of NMP for 1965 was 71.7. However, this was lower than the published deflator for any of the component sectors of the economy,

this study the Soviet definition of income is used, the coverage issue (i. e.,the omission of services from NMP) can be set aside.

For the period 1958-1961, for Soviet aggregate NMP, Cohn found that sector weighting practices (attribution of the turn-over tax) account for a one per cent difference, and sector output differences (price indexing) account for a difference of six tenths of one per cent. However, for 1961-1966, these contributions to growth index differences amounted to three tenths and four tenths of one percent, respectively.[12] One can speculate, due to the price revisions of the late sixties, and based on the evidence regarding the relative consistency of implicit and explicit price indexes over time (see footnote 11) that the divergence between western and official growth indexes remained small over the remainder of the period of the study.

Sectoral growth indexes could be computed as a by-product of the TsSU calculation of NMP, since what is called the "double deflation" method of calculating comparable-ruble incomes is used. For most sectors, this involves first calculating gross output in comparable prices,

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prompting Vainshtein to advocate the use of current ruble values as better indicators. My calculations reveal that the problem continued through 1977, although not in so severe a form. This is some evidence that price-induced differences between official and western growth indexes could be expected to be less in recent years than in the past.

[12]Cohn, "National," p. 137.

applying deflators to the material inputs time series, and taking the difference to arrive at net output. For transportation and trade, TsSU uses a different procedure. In both cases, it is assumed that the net/gross ratio prevailing in the base year remains constant. This ratio is then multiplied by a measure of gross freight or gross trade turnover (gross trade turnover is measured in value terms). The sectoral values are then summed to arrive at aggregate NMP.[13]

However, application of the published NMP aggregate and sectoral growth indexes leads to an interesting problem. In building the data set for this model, for all the republics for which sufficient official data were available, aggregate and sector NMP were calculated, using the published 1965 values in current rubles and the published growth indexes. For periods prior to 1965, the sum of the individual sectors in "1965 rubles" add up to more than NMP, and by an amount far greater than could be accounted for by rounding. Indeed, if 1970 is chosen for the base year, the sector value for agriculture in Lithuania exceeds the value of total NMP for 1960 in "1970 rubles." This obviously casts some doubt on the growth indexes. It also raises the question of whether or not republic NMP growth indexes are calculated by the double-deflation method Cohn (citing A. I. Ezhov, Sistema i metodologiia pokozatelei sovetskoi statistiki [The system and methodology of Soviet statistical

[13]Ibid., p.124.

indicators] (Moscow: n.p., 1959), pp. 314-315) describes. Or, perhaps the sector growth indexes published are not the same as would be implied in the individual sector deflation processes used to establish aggregate NMP in constant rubles.

In Table A.1 are presented data covering NMP for Lithuania in both actual transaction (fakticheski deistvovavshikh tsenakh) and 1965 comparable rubles (sopostavimykh tsenakh 1965 g.) prices, for the period 1960 to 1975.[14] While the 1975 constant-ruble value divided by the 1965 comparable ruble value gives a ratio of 2.06, which is the official growth index value for 1975 in terms of 1960, it is interesting to note the 5.1 per cent difference between the actual price NMP for 1965 and the 1965 comparable ruble NMP. Apparently 1965 comparable rubles are considerably different from the rubles used in 1965 transactions. Since there is no obvious reason for a discrepancy of this magnitude, it must for now remain a mystery.

In summary, I have chosen Soviet official growth indexes to establish constant ruble value levels of NMP,

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[14]In Table A.1 and all tables in this appendix, sources that are official statistical handbooks will be cited by abbreviated title and republic. The complete facts of publication on these sources and a key to the abbreviation scheme are in the Bibliography, in the section for statistical handbooks. The abbreviation NARKHOZ 19** refers to the national statistical handbook for the 19** year. An asterisk beside a table entry indicates that the value so annotated involves estimation. Double asterisks indicate there were insufficient data to provide the basis for estimation.

TABLE A.1

NATIONAL INCOME OF LITHUANIA
(millions of rubles)

Year	Actual Transaction Prices	1958 Comparable Rubles	1965 Comparable Rubles
1960	1796.2	1889.3	**
1961	1966.0	1999.1	**
1962	2171.7	2045.8	**
1963	2345.9	2378.3	**
1964	2513.3	2630.6	**
1965	2760.8	2874.3	2626.1
1966	2948.3	**	2833.2
1967	3259.7	**	3198.9
1968	3460.0	**	3465.5
1969	3861.7	**	3821.6
1970	4204.5	**	4115.7
1971	4491.6	**	4403.4
1972	4621.5	**	4636.6
1973	4746.1	**	4835.0
1974	5057.2	**	5072.7
1975	5535.1	**	5410.1

** Indicates data not published in the source.

Source: EKLi (1975).

aggregate and by sector, and for growth rates of NMP, aggregate and by sector. With that choice are some general caveats to the reader. First, the coverage of the data is different than the more familiar western measures, primarily due to the exclusion of most services. Further, the prices used are not scarcity prices by any definition. The national growth rates tend to be slightly overstated, for the reasons discussed above; for the period of this study, the error is not large, and is likely to have shrunk during most of the period covered. There are some additional

uncertainties injected due to the treatment of the T.O. tax and its attribution among republic income accounts. Finally, there are questions raised by the failure of the parts of comparable ruble NMP to add to the official whole.

The method used here will be to consider total 1965 comparable ruble NMP to consist of the sum of the 1965 comparable ruble values-added by sector. This figure will usually exceed the 1965 ruble value obtained by using the aggregate NMP growth indexes for years prior to 1965, and fall short of it afterward. The values of Q (NMP created in industry; transport; communications; and trade, material supply, procurement, and "other material activities"), QA (NMP created in agriculture), and NMP implied by the official aggregate growth indexes are given below in Tables A.2 through A.4, respectively.

The method used in general to construct these tables was to take the 1965 ruble value of NMP, aggregate and by sector, and multiply those numbers by the appropriate growth indexes.[18] This method requires that both aggregate and sector NMP values be published for 1965 in current year rubles, and that growth indexes covering 1958-1977 be published for NMP and its five principal sectors. This was true for only two of the selected republics, Lithuania and

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[18]A base year of 1965 was chosen chiefly because comparable ruble values of NMP were calculated in 1958 prices from 1959 to 1965, and in 1965 prices thereafter (see NARKHOZ 1967, p. 919). In principle, there seemed to be some advantage in choosing the splice year, and in practice the choice of a 1965 base year gave much more satisfactory results than did the use of 1970.

TABLE A.2

Q: NMP IN NON-AGRICULTURE
(millions of 1965 rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	*Tadzh-ikistan
1958	788	**	**	1873	548	392
1959	898	**	**	2022	600	448
1960	1026	1358	705	2174	630	470
1961	1165	*1379	*791	2287	674	528
1962	1239	*1432	*852	2522	740	556
1963	1408	*1573	*911	*2857	855	730
1964	1590	*1765	*1005	*3085	877	735
1965	1765	2049	1114	3434	1002	805
1966	1932	2225	1225	3991	1112	974
1967	2192	*2465	1355	*4316	1260	1020
1968	2512	*2770	1514	*4701	1432	1094
1969	2856	*2788	1627	*4798	1521	1087
1970	3167	*3222	1749	5213	1656	1217
1971	3428	3580	1870	5779	1758	1378
1972	3749	3847	1994	6287	1877	1464
1973	4004	4090	2147	6779	1994	1528
1974	4254	4342	2279	7530	2127	1640
1975	4647	*4574	2432	8187	2223	1784
1976	4945	*4840	2589	*8703	2356	1869
1977	5188	*4967	2704	*9064	**	1969

Sources: 25LSLi, NKLi (65), EKLi (70, 72, 73, 74, 75, 77), SLVTs, EKSL, LVTs (68, 69), NKL (71, 72, 73, 74, 75, 77), NKE (67, 69, 71, 75, 77), UZ7L, SUZ40L, NKU (67, 68, 70, 71, 75, 77) KZ50LSV, KVTs (71), NKKi (63, 71, 74, 75, 77), STZ50L, NKT (64, 65, 69, 71, 75, 77).

Kirgizia. For three others (Latvia, Estonia, and Uzbekistan), growth rates were published by sector for some of the years, giving at least the benchmark years of 1960, 1965, and 1970, plus data for a number of other intervening years. For Estonia prior to 1965, only aggregate growth indexes and current-price sector shares were published,

TABLE A.3

QA: NMP IN AGRICULTURE
(millions of 1965 rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	*Tadzhikistan
1958	838	**	**	1561	425	367
1959	890	**	**	1779	444	422
1960	931	631	378	1748	476	409
1961	831	*602	*358	1639	488	478
1962	749	*455	*397	1763	521	447
1963	931	*555	*353	*2139	604	489
1964	968	*647	*386	*2136	605	523
1965	997	644	374	2062	602	463
1966	1037	*626	325	*2200	644	470
1967	1166	*707	382	*2115	656	480
1968	1106	*638	382	*2110	662	470
1969	1116	*688	351	1783	572	453
1970	1096	644	370	2413	655	526
1971	1126	573	389	2289	625	547
1972	1027	509	292	2331	660	519
1973	967	489	303	2475	666	538
1974	937	457	318	2681	631	550
1975	877	*421	318	2496	632	546
1976	817	*454	329	*2775	637	522
1977	817	*408	314	*2804	**	531

Sources: See Table A.3.

while for Latvia (which had growth index coverage only for 1960, 1965, and 1970-1975) and Uzbekistan aggregate growth indexes, current price NMP, and current price sector NMP (either in rubles or as a share of the whole) were available for years not covered by sector growth indexes. For Tadzhikistan, only aggregate growth indexes and current-price sector shares are published, for the entire period of the study.

TABLE A.4

NMP (OFFICIAL AGGREGATE)
(millions of 1965 rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	*Tadzh-ikistan
1958	1467	1508	830	**	**	689
1959	1624	1643	955	**	**	792
1960	1815	1824	1041	3790	1067	811
1961	1920	1915	1124	3866	1127	933
1962	1963	1884	1134	4169	1228	982
1963	2281	2141	1259	4510	1400	1087
1964	2523	2382	1394	4890	1459	1168
1965	2761	2578	1488	5496	1603	1267
1966	2982	2681	1548	5771	1756	1343
1967	3368	3042	1741	6320	1946	1470
1968	3644	3248	1890	6650	2110	1521
1969	4031	4803	1994	6595	2129	1546
1970	4334	3738	2143	7639	2322	1736
1971	4638	4018	2292	8024	2423	1914
1972	4887	4230	2336	8574	2578	1964
1973	5080	4454	2500	9233	2708	2040
1974	5328	4665	2634	10222	2815	2182
1975	5687	4963	2812	10607	2916	2319
1976	5853	5272	2991	11541	3056	2370
1977	6074	5461	3095	11981	**	2484

* Note: Comparable ruble growth rates are published for Tadzhikistan; however, the 1965 base value is estimated.

Sources: 25LSLi, NKLi (65), EKLi (70, 75, 77), EKSL, NKSL, LVTs (68), NKL (70, 77) NKE (70, 75, 77), SUZ40L, NKU (67, 68, 70, 71, 75, 77), NKKi (74, 75), KZGSV77, NKT (64, 65, 69, 71, 75, 77).

To fill in the gaps in the series for Estonia, Latvia, and Uzbekistan, and estimate the entire series for Tadzhikistan, deflating sector values of NMP to comparable prices by means of published national sector and industrial branch price indexes was considered. This proved

unsuccessful for a number of reasons.

An alternative method, used here, is to estimate the implicit price deflator for the missing years for those republics for which partial data are available,[11] based on the data from an economically similar republic. The procedure is first to estimate the missing deflators for NMP and its sectors. Then, for years for which current ruble aggregate NMP is not published, it is estimated by using growth-index implied comparable ruble values and estimated deflators. The next step is to disaggregate current price NMP into its sector components, deflate the current price sector series by the appropriate estimated sector deflators,

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[11]Bond, "Multiregional," p. 63, footnote 21 employs a similar method, but with a slightly different formula for interpolating the the missing deflators. Since data are available to calculate implicit deflators for both Lithuania and Kirgizia for the entire period (except 1977 for Kirgizia), for aggregate and sector NMP values, these values were used to estimate the implicit deflators for missing years, Lithuania for the Baltic and Kirgizia for Uzbekistan. The rationale was that price fluctuations would be more similar for republics in the same region and with similar economic structures. For estimating deflators for years lying in an interval between two other years for which implicit deflators are known, estimation was via the formula

$$D_t = \{R_0 + t(R_T - R_0)/T\} \cdot P_t$$

where T is the length of the interval for which the data are incomplete, D_t is the estimated deflator for the year t, R_0 is the ratio between the implicit deflator for the republic whose data is being estimated and the "key" republic for which data are available (Lithuania and Kirgizia), on the beginning benchmark year, R_T is the ratio for the ending benchmark year, t is the index for the intervening year for which the deflator is being estimated, and P_t is the deflator in year t for the key republic. For periods that have a ratio known at only one end of the interval, the formula is

$$D_t = R_0 \cdot P_t.$$

and then sum the deflated sector values to get Q, QA, and NMP in comparable rubles. Growth rates are then obtained by applying the appropriate operations to Q and QA.

For Tadzhikistan, since no implicit deflator is available for any year,[17] the procedure used was to assume that all deflators were the same as for Uzbekistan. This procedure leaves a lot to be desired, and the results of fitting the model suggest that substantial error is involved, for the purposes of fitting a growth model. The ramifications of this point are discussed in Chapter IV.

Investment and the Capital Stock.

For this study, the capital stock is limited to fixed assets, or, in Soviet parlance, basic funds (osnovnye fondy). Basic funds include "buildings, structures, transmitting equipment, machinery, and equipment (manual and power machines, and measuring and regulating devices and mechanisms, laboratory equipment, computers, means of transportation, instruments, draft and productive [i. e., breeding] livestock, and other kinds of basic funds."[18] Data on basic funds (hereafter called the capital stock) are published by major sector of both the productive and non-productive spheres, with the degree of disaggregation varying among republics.

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[17]In fact, the only value given for ruble NMP in Tadzhikistan is for aggregate per capita NMP in 1970, in current year rubles, published on page 56 of NKL (71).

[18]NARKHOZ 1977, pp. 598-599.

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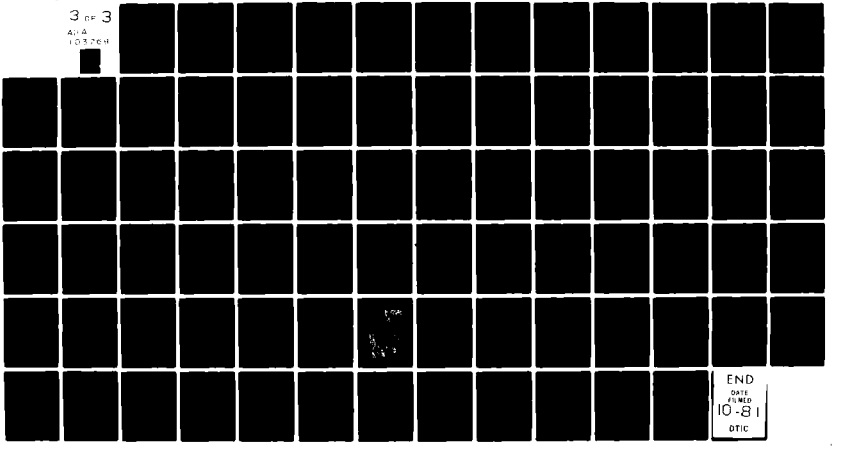

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Data have been collected for this study for three variables that among them give exhaustive coverage of fixed capital in the Baltic and Central Asia: K (productive, non-agricultural); KA (productive, agricultural); and KNP (non-productive). These data are given in Tables A.5 through A.7, respectively. The primary source for the capital stock data was a U. S. Department of Commerce study by James Gillula giving end of year values for 1960 through 1975 except for occasional gaps due to lack of published data. The series have been extended back to 1959 (when possible) and forward to 1976, and re-labeled as 1 January 1960 to 1 January 1977. The method of extension was to apply published republic growth rates in "comparable prices" to the Gillula figures. For Latvia, some data missing in the Gillula study have been estimated for the early sixties based on implied growth rates in another source.[19] Further, entries for years for which data are missing have been interpolated, as noted in the table. These data thus contain measurement errors.

Information used in constructing the capital stock entries in the statistical publications originate with the value of fixed capital assets carried on enterprise books.[20] The values reported are gross of physical depreciation and

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[19]The source is SLVTs. The pricing used in this source is not clear, but in any event it is felt the results of this process are quite apt to be superior to interpolation.

[20]Raymond P. Powell, "The Soviet Capital Stock from Census to Census, 1960-1973," Soviet Studies 31 (January 1979), p. 66.

TABLE A.5

K: CAPITAL STOCK IN NON-AGRICULTURE
(millions of 1955 rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	**	**	**	**	**	**
1959	**	**	**	**	**	**
1960	1163	1535	1129	**	546	489
1961	1305	1630	1233	2577	619	597
1962	1451	1775	1357	2909	710	670
1963	1642	1940	1491	3267	815	771
1964	1825	*2179	1637	3773	922	882
1965	2048	*2447	1796	4331	1062	982
1966	2286	2748	1958	4894	1197	1116
1967	2527	*2957	2106	5717	1466	1241
1968	2773	3183	2235	6461	1641	1416
1969	3082	3446	2357	7097	1842	1517
1970	3403	*3687	2579	7875	2043	*1665
1971	3768	3947	2762	8835	2274	1827
1972	4176	4220	2994	9778	2447	1955
1973	4544	4646	3277	10824	2727	2354
1974	4946	4953	3533	11928	2946	2614
1975	5370	5345	3781	12964	3277	2876
1976	5847	5803	4016	14111	3591	3140
1977	6279	6289	4202	15210	**	3414

Sources: U. S., Dept. of Commerce, "The Regional Distribution of Fixed Capital in the USSR," NKLi (65), EKLi (77), SLVTs, NKL (77), NKE (67, 77), NKU (77), NKKi (63), NKT (62, 77).

obsolescence, and therefore overstate the value of the stock systematically. Further, the exclusion of inventories is a divergence from most Western practices. Some data, in current year rubles, are published on inventories, but their use to supplement the basic funds concept of capital has not been undertaken for this study. The reason is that collecting these data and converting them into a common

TABLE A.6

KA: CAPITAL STOCK IN AGRICULTURE
(millions of 1955 rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	**	**	**	**	**	**
1959	**	**	**	**	**	**
1960	878	657	416	0	475	398
1961	919	827	445	1620	510	442
1962	973	886	494	1750	552	479
1963	1034	965	518	1895	626	539
1964	1094	*996	545	2187	688	601
1965	1164	*1028	583	2300	770	667
1966	1242	1061	600	2576	839	722
1967	1390	*1133	638	2961	918	795
1968	1520	1210	694	3270	988	883
1969	1680	1297	748	3645	1082	959
1970	1859	*1329	806	3921	1147	*1054
1971	2090	1487	877	4393	1226	1159
1972	2297	1587	946	4943	1310	1298
1973	2553	1756	1037	5461	1454	1387
1974	2841	1925	1148	6194	1605	1517
1975	3117	2089	1269	6981	1747	1662
1976	3534	2202	1384	7807	1909	1762
1977	3866	2356	1484	8662	**	1903

Sources: See Table A.5.

value for the entire series are virtually impossible for a study of this scope, due to problems in price comparisons.[21]

Both the capital stock and investment series used in this study have been taken in 1955 prices, with revisions

[21]Padma Desai, "The Production Function and Technical Change in Postwar Soviet Industry: A Reexamination," American Economic Review 66 (June 1976), pp. 379-380, estimated the value of inventories for the Soviet economy as a whole. Bond, "Multiregional," pp. 49-50, and Cohn, "National Income," p. 140, both note substantial problems in establishing a deflator for a Soviet inventory series.

TABLE A.7

KNP: "NON-PRODUCTIVE" CAPITAL STOCK
(millions of 1955 rubles)

Year	Lith-uania	Latvia	Estonia	CENTRAL ASIA		
				Uzbek-istan	Kirgizia	Tadzh-ikistan
1958	**	**	**	**	**	**
1959	**	**	**	**	**	**
1960	1558	2089	1171	**	783	753
1961	1660	2227	1239	3115	869	840
1962	1754	2342	1310	3395	956	910
1963	1861	2471	1393	3645	1039	979
1964	1979	*2601	1480	3894	1120	1080
1965	2110	*2708	1610	4205	1220	1195
1966	2237	2823	1677	4423	1320	1277
1967	2377	*2945	1755	5103	1446	1348
1968	2586	3072	1843	5666	1574	1475
1969	2789	3204	1965	6355	1747	1624
1970	2978	*3315	2048	6699	1815	*1749
1971	3194	3431	2196	7169	1977	1885
1972	3449	3578	2347	7870	2227	2045
1973	3708	3791	2552	8492	2414	2188
1974	4064	3970	2683	9176	2594	2351
1975	4394	4156	2813	9863	2772	2476
1976	4744	4354	2948	10492	3018	2650
1977	5093	4553	3110	11311	**	2825

Sources: See Table A.5.

(reductions) of 1958 and 1962. The principal reason for choice of 1955 prices is that for some republics data on levels of the capital stock are only available in those terms.

Each of the major price revisions (1955-56 and 1967-1969) was followed by a capital stock census, with valuations basically being in terms of the newly-established price lists. These censuses occurred in 1960 and in

1971-1972, with differences both in coverage and in the approach to pricing assets not in current Soviet production. The 1972 census was more extensive in coverage, and valued assets not covered by current price lists by comparing the attributes of the asset in terms of its substitutability in production with items on the current price list. The approach to valuation of such items in the 1960 census was to estimate the cost of producing the asset in the Soviet Union in 1960.[22]

Therefore, published comparable ruble growth series for capital stocks covering the period (regardless of the pricing regime cited with the table) must have been spliced together, with the splices covering five price regimes in two major groups. These price regimes were the 1955 industrial prices, with 1955/1956 construction estimating costs and a 1958 revision, the same with a 1962 revision to construction costs, the 1967/1969 prices, 1967/1969 prices with a 1973 revision in construction costs, and finally the same with a 1976 revision. Further, a major splice must join the data from the period after the most recent census with data from the earlier period, likely around 1973 as the results of the census became available.

Capital investment (kapital'noe vlozhenie) is valued in comparable rubles, in the same manner as fixed capital assets. Further, the capital investment data used here cover investment in fixed assets, and are therefor

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[22]Powell, "The Soviet Capital Stock," pp. 56, 59.

consistent with the measure of capital stock used.[23] The actual construction of the data series in Tables A.8 and A.9 was by collecting data on investment, by sector, and aggregating these as appropriate to get values for I (non-agricultural productive sphere investment) and IA (agricultural productive sphere investment). Investment in non-productive spheres does not figure in the model. Values from tables published in some value unit other than 1955/62 rubles are converted to that base by chaining them into the series. While this method introduces some error it is likely small.

The coverage of the official data is also a problem. For some republics, the series are published for both all investment (including that by collective farms and private individuals in housing) and for state and co-operative (non-kolkhoz) investment, for some republics in the study sample only total investment by sector is given, and for others only investment by state and and cooperative enterprises is given by sector. Further, for some republics (Estonia and the Central Asian republics) investment in trade, procurement, material supply and "other activities in the material sphere" are aggregated with non-productive sphere investment in a single entry. Therefore estimation in two steps was necessary. First, to separate the material sphere activities out of the aggregate, an estimate of the portion

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[23]Cohn, "National Income," p. 140; NARKHOZ 1977, pp. 617-618.

TABLE A.8

I: INVESTMENT IN NON-AGRICULTURE
(millions of 1955 rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	*Estonia	*Uzbek-istan	*Kirgizia	*Tadzhik-istan
1958	*100	**	**	290	84	66
1959	*125	*137	**	294	100	86
1960	129	*140	**	369	108	92
1961	*160	*165	132	429	118	105
1962	*194	*185	133	460	130	114
1963	*191	*204	141	546	149	122
1964	*248	*239	156	621	150	142
1965	257	263	169	775	175	180
1966	243	255	152	836	173	189
1967	280	260	171	896	207	174
1968	309	271	200	915	229	186
1969	318	317	203	931	233	191
1970	360	362	234	989	261	216
1971	376	341	245	990	276	254
1972	398	367	244	1020	278	295
1973	420	397	264	1118	283	257
1974	426	482	256	1092	316	272
1975	489	*519	251	1182	329	292
1976	509	*539	234	1239	345	329
1977	502	*545	249	1308	0	353

Sources: NKLi (65), EKLi (70, 75, 77), EKLS (66), NKL (75, 77) NKE (67, 69, 70, 71, 75, 77), UZ50L, NKU (65, 67, 70, 75, 77), NKKi (61, 67, 71, 75), KiZGSV77, NKT (65, 72, 76, 77).

accounted for by material sphere investment was developed based on similar republics for which the data were available in disaggregated form (Latvia for Estonia, a weighted average of Georgia, Armenia, and Kazakhstan for Central Asia). These ratios were then used with the published total values of the composite sector to estimate investment in the trade sector. The precise details of the procedure and the

TABLE A.9

IA: INVESTMENT IN AGRICULTURE
(millions of 1955 rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	83	**	**	239	50	53
1959	75	58	**	273	57	60
1960	77	68	**	295	64	68
1961	98	76	40	319	69	67
1962	103	78	49	319	70	74
1963	123	90	56	393	92	86
1964	139	103	65	529	108	115
1965	155	109	68	610	121	137
1966	192	134	82	620	123	135
1967	222	152	105	642	133	142
1968	258	168	115	702	155	149
1969	278	186	114	722	154	151
1970	297	196	133	840	162	150
1971	320	213	142	943	178	171
1972	335	233	153	1053	206	178
1973	372	253	174	1238	221	199
1974	374	262	185	1387	233	210
1975	415	293	190	1487	244	226
1976	440	265	186	1525	254	231
1977	452	256	199	1586	**	254

Sources: NKLi (65), EKLi (70, 75, 77), EKLS (66), NKL (75, 77), NKE (67, 70, 71, 75, 77), NKU (67, 70, 75, 77), NKKi (63, 74, 75), KiZGSV77, NKSA (63), NKT (64, 68, 72, 76, 77).

numerical values involved are available from the author's worksheets.

Regarding the differences in organizational coverage, which affect only the non-agricultural material sector, one of the key questions in this study is the influence of central investment on regional growth. Hence, the decision was to calculate all republic series for non-agricultural

productive sphere investment in terms of investment by "state and cooperative enterprises," thereby omitting kolkhoz investment outside of agriculture. For some republics, this involved estimating the kolkhoz share of investment in non-agricultural activities by sector.

New capital put into productive use (vvod v deistvie osnovnykh fondov) (the variable GKF in the econometric model) includes the value of buildings and structures completed in the accounting period, and the value of machinery of all types put into commission, and in general the value of all stocks, placed into use in a given accounting period, that when in economic use are a part of basic funds.[24] The measure used here is all basic funds put into use, of both the productive and non-productive spheres.

While it would have been optimal to have had the values of activated new capital by sector for use in the investment-capital accumulation block of the model (see Chapter II), disaggregated data was only available for some republics for the more recent years. Accordingly, GKF only enters the analytic model as a possible determinant of factor productivity growth.

Wages.

The money (or nominal) wage data used in this model were figured for the non-agricultural and the agricultural material sectors, and are presented in Tables A.10 and A.11,

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[24]NARKHOZ 1977, p. 617.

respectively. Wages will be discussed here in three categories. These are the non-agricultural productive sphere, and two categories in the agricultural productive sphere, sovkhoz wages and kolkhoz wages.

TABLE A.10

W: NON-AGRICULTURE AVERAGE WAGES
(Current rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1958	**	80.4	*82.7	**	**	**
1959	**	*81.8	*84.3	**	**	**
1960	*78.7	83.4	87.1	76.8	80.8	*85.1
1961	*82.1	*87.0	*88.8	*78.0	*81.0	*83.6
1962	*84.9	*89.2	*91.5	*80.9	*83.8	*86.3
1963	*87.5	*91.0	*94.4	*83.1	*85.9	*88.3
1964	*90.6	94.6	*98.1	*85.7	*88.5	*90.8
1965	95.8	98.9	104.5	95.0	95.9	98.6
1966	100.6	103.2	110.0	98.6	*101.3	*101.6
1967	107.0	111.3	117.2	104.9	*105.2	*107.9
1968	115.7	120.7	128.6	*114.2	*113.9	115.1
1969	121.5	126.8	135.8	116.9	*116.4	*119.5
1970	128.9	134.0	143.2	125.5	123.7	126.1
1971	133.0	139.5	147.6	128.9	126.8	129.3
1972	138.5	144.4	152.9	132.4	129.9	132.6
1973	142.7	147.8	157.0	136.1	132.8	133.8
1974	147.0	151.7	162.0	147.2	145.2	*145.6
1975	153.0	156.6	168.5	152.1	148.1	149.6
1976	*163.9	*166.4	*179.4	*156.6	*150.9	152.3
1977	*167.0	*169.8	*183.8	*159.3	**	151.7

Sources: EKLi (70, 75, 77), EKSL, LVTs (68, 69), NKL (75, 77), NKE (69, 72, 74, 75, 77), NKU (67, 70, 75, 77), NKKi (72, 75, 77), STZ50L, NKT (71, 77).

The labor wage (zarabotnaia plata) in the non-agricultural material sphere includes all wage payments out of the wage fund (fond zarabotnoi platy) divided by the

TABLE A.11

WA: AGRICULTURE AVERAGE WAGES
(Current rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1958	**	**	**	**	**	**
1959	**	**	**	**	**	**
1960	*19.2	36.4	47.5	*39.4	40.5	*33.0
1961	*20.7	*39.1	*51.9	*44.2	*41.1	*40.0
1962	*25.2	*40.3	*54.6	*44.5	*47.9	*37.3
1963	*30.8	*42.7	*59.4	*59.2	*57.1	*48.9
1964	*38.9	51.8	*61.8	*58.1	*59.0	*51.6
1965	53.1	59.2	72.0	70.0	67.9	64.4
1966	59.4	65.5	82.0	74.3	*71.7	*66.7
1967	67.5	75.0	95.8	77.3	*73.4	*72.3
1968	74.4	83.7	103.1	79.5	*75.4	75.7
1969	79.6	88.3	108.6	77.1	*75.2	*77.3
1970	86.7	94.9	123.2	93.5	79.9	86.7
1971	94.9	105.2	137.7	93.1	84.6	92.1
1972	102.4	108.7	144.4	95.3	87.4	86.5
1973	107.9	115.1	147.6	96.6	93.1	92.6
1974	111.1	118.1	156.4	106.3	97.0	98.1
1975	115.2	121.9	166.7	104.5	102.2	97.9
1976	123.0	131.6	180.2	111.9	102.5	99.6
1977	128.9	137.7	187.4	122.1	**	102.2

Sources: Chandler, The Effects of the Private Sector, NARKHOZ (64,65), NKLi (65), EKLi (70, 75, 77), EKSL, NKSL, LVTs (69), NKL (75, 77), NKE (69, 72, 74, 77), NKU (67, 68, 69, 70, 75, 77), NKKi (72, 75), KiZGSV77.

average registered number of workers and employees. This includes, besides regular wages and salaries, legal supplemental payments (e. g., severance pay), vacation pay, utilities, housing subsidies, and payments in kind (evaluated at state retail prices). Further, since 1967 calculations of average wages have also included certain

bonuses formerly included in the enterprise director's fund.[23] Consequently, data for before 1967 may not be entirely comparable to data since 1967. The sources are not explicit on this point. The implication is that the data may understate the agriculture-non-agriculture relative wage difference for the first few years of the series, compared to more recent years.

There may also be some small systematic over-statement of average wages, due to the handling of workers holding more than one job or working in an enterprise five days or less per month, since these are not "registered" workers, but their wages are included in the wage fund.[24] Finally, there are, due to the way the data are collected, undoubtedly errors made by counting some workers in the non-material sphere in the material sphere category.

Data for wages in the non-agricultural sectors of material production have been taken from tables giving the wages by sector for workers and employees in the state sector. These data are generally available for 1960 and 1965 through 1975. Data availability for other years varied by republic. For Kirgizia, disaggregated wage data are available only for 1960, 1965, and 1970 through 1976. For all republics except Kirgizia, average money wages for the state sector are available for the entire period. For

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[23]Gertrude E. Schroeder, "Soviet Wage and Income Statistics", in Treml and Hardt, Soviet Economic, pp. 291-292.

[24]Ibid., p. 293

Kirgizia, only 1960 and 1965 through 1976 are available.

Generally, the non-agricultural wages in Table A.10 are computed as the weighted average of sector wages, by republic, with weights based on the relative size of a given sector in the total of non-agricultural sectors for which wage data were given. For the cases where only average wages are available, a linear equation was fitted relating non-agricultural material sphere average wages to the average wage in all state employment. This relationship was quite tight (the R^2 was invariably .98 or higher). The results of this regression were used to estimate average material sphere non-agricultural wages based on the over-all average wage. For Kirgizia, entries for 1961-1964 were estimated using the average data from Tadzhikistan. The fit of this relationship for 1965-1975 was also quite good (R^2 = .9932).

The problem for the agricultural sector was more difficult. Prior to 1965 collective farmers did not receive a true wage, but rather shared in the net earnings of the collective farm. At the same time, workers on the state farms were paid on the same basis as workers in other state employment. While socialized sector (collective and state farms) wages are published or a basis exists for their estimation, earnings from private plots, substantial in some years, are not published in consistent time series form.[27]

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[27]For a general idea of the relative importance of private plot incomes on a republic basis, see Gertrude E. Schroeder, "Regional Income Differentials: Urban and Rural,"

Accordingly, entries for agricultural wages are limited to wages from employment on state or collective farms. They are determined as the weighted average of collective farm and state farm wages, with weights determined by relative employment levels on the two types of farms.

State farm wages are published in the same tables as wages for employment in other state activities. The description in the data source indicates that they include the wages of workers properly in other sectors. This is because the reporting base is organizational (e. g., the individual sovkhozes), and not all workers at that level of aggregation are engaged in agriculture, strictly speaking. However, data that are theoretically more satisfying are not consistently published across time and republics. Entries for years for which disaggregated wages data were not published have been estimated as described above in the discussion on non-agricultural wages.

Collective farm wages are a more difficult matter. The collective farm average annual wage, or the total outlay for wages and the total number of annual average workers on collective farms, is published more or less regularly for 1960 and for 1965 to 1977, though there are variations from republic to republic. When direct wage data were available, they invariably included both money wages and payments in kind, though only a single total figure was given.

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in NATO, Economics Directorate and Information Directorate, eds., Regional Development in the USSR. Trends and Prospects (Newton, MA.: Oriental Research Partners, 1979), p. 32.

For the remaining years, Clark Chandler[28] gives the average man-days spent per able-bodied collective farmer in collective employment for 1962, 1963, 1965, 1967, 1968, and 1970, and the ruble wage per man-day for 1962 through 1970, by republic. Wage figures calculated using Chandler's data are consistently smaller (by about 20 per cent) than those given for kolkhoz employment in the republic yearbooks.[29] The method used to reconcile the figures was to determine the average ratio between wages estimated using Chandler's data and the entries in official statistical handbooks, for overlap years, and then use that ratio to adjust the estimates for 1962 and 1963.

Total money incomes for collective farms are also published for 1960 to 1965. Since over that period, collective farm wage payments were a function of farm incomes, farm wages for the years in which they were officially given (1960, 1965) and for the years for which they could be estimated from Chandler's data (1962, 1963) were regressed against farm incomes to form the basis for estimating figures for 1961 and 1964. The fit in this linear relationship was surprisingly good, all factors considered, with values for R^2 of .97 (Estonia) or higher.

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[28]Clark John Chandler, "The Effects of the Private Sector on the Labor Behavior of Soviet Collective Farmers" (Ph.D dissertation, University of Michigan, 1978), pp. 155, 157.

[29]"Man-days per able-bodied collective farmer" are different than "man-days per average annual collective farmer." However, the difference is probably not substantial for the purposes of this study.

The wage data discussed so far pertains to money, as opposed to real, wages. For the purposes of this study, measures in comparable prices are desired. Soviet statistical sources offer some indexes of real wages and real incomes, but these were deemed unusable here. Indexes of the real wage on a national basis have not been published for recent years (since 1956). However, these indexes are available for Latvia through the mid-sixties and for Uzbekistan through 1971. Table A.12 gives the relationship between average money wages, real wages, and the state retail price index for some available years for Uzbekistan. Data are published over the whole period for real income. These data include net wages, a definition of wages so broad as to make use of this index unreliable for the purposes at hand.[30]

An alternative approach would be to deflate money wages by a consumer price index; such an index is not published. An index of state retail prices based on a sample of goods is published over the period for all republics, but is subject to two shortcomings. First, it excludes "communal" (e. g., housing) and "cultural" (e. g., dry cleaning) services. Second, the following are not considered changes which would affect the index: prices on goods not previously produced; new prices for goods whose technical

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[30]Schroeder, "Soviet Wage and Income Statistics," pp.304-305. Indexes of real income include money and "natural wages," outlays from pensions, social security benefits, and other stipends (see NARKHOZ 1977, p. 621).

TABLE A.12

REAL WAGES, MONEY WAGES AND THE RETAIL PRICE INDEX: UZBEKISTAN

Year	Money Wages 1960=100	Real Wages 1960=100	State Retail Price Index 1960=100
1960	100	100	100
1965	127.2	127.4	99
1970	163.8	161	98.5
1971	167.9	165	98.7

Sources: NKU (1969,1971).

specifications have changed; temporary prices; new prices on goods removed from production; and reduced prices on goods not in demand.

The same sort of "new products" problem that is found in industrial wholesale pricing is characteristic of retail pricing, including higher prices on "new" products that are in fact of inferior quality. Further, the exclusion of temporary prices tends to also act to understate the change in prices. The net quantitative effect of these influences is not fully known, but qualitatively it is to understate inflation, and in fact to reverse the sign on average price changes over some periods. Finally, collective farm markets, an important source of food accounting for sizeable money outlays, are not included in these indexes.[21]

[21]Morris Bornstein, "Soviet Price Statistics," in Treml and Hardt, Soviet Economic, pp. 371-375.

The retail price index is compared to the index of real wage growth and growth of money wages in Table A.12 above. The difference between 1971 official real wage values, in comparison to 1960, and wages deflated by the retail price index, is slightly more than three per cent. Considering these small differences, the problems associated with the retail price indexes, and the small difference between current wages and both official real wages and money wages deflated by the official retail price index, the decision for this study is to use wage data in current year rubles.

Consumption.

Tables A.13 and A.14 give total and private consumption data, respectively, as available. As the table indicates, these data have not been published for the entire period. The values for the early sixties and since 1975 are missing for most republics, though as with other information, there are republic-to-republic variations.

In Soviet practice, used national income (ispol'zovannyi natsional'nyi dokhod) differs from produced national income (proizvedennyi national'nye dokhod) by "...losses not normally attributed to cost (accidental damages, abandoned construction, and the like)" and the foreign trade balance.[32] Used national income is divided into the "accumulation fund" (fond nakopleniia) and the

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[32]Becker, "National Income," p. 74. For the republics, the trade difference includes the republic's net position with the rest of the USSR, of course. This point is

TABLE A.13

C: TOTAL CONSUMPTION
(millions of current rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	**	**	**	**	**	**
1959	**	**	**	**	**	**
1960	**	**	**	**	**	**
1961	1421.0	1503.0	863.7	**	**	**
1962	1570.5	1595.0	912.1	3147.7	**	**
1963	1664.0	1639.0	947.0	3468.7	**	**
1964	1778.2	1728.0	1026.1	3795.4	**	**
1965	1915.1	1828.0	1082.4	4160.0	1187.3	**
1966	2147.5	1986.0	1151.9	4632.3	1317.5	1074.0
1967	2391.6	2173.0	1267.4	5087.1	1431.6	**
1968	2596.6	2384.0	1393.3	5562.5	1531.8	**
1969	2775.2	2539.0	1475.9	5895.8	1666.0	**
1970	2980.2	2762.0	1605.6	6412.1	1803.1	**
1971	3205.8	2913.0	1681.7	7058.6	1926.3	**
1972	3323.8	3041.0	1751.7	7415.0	2042.2	**
1973	3540.9	3166.0	1838.2	7968.6	2208.6	**
1974	3704.8	3305.0	1915.1	8512.8	2349.6	**
1975	**	3507.0	2033.0	9236.9	**	**
1976	**	3693.0	2155.0	9856.6	**	**
1977	**	**	2240.9	10515.2	**	**

Sources: NKLi (65), EKLi (69, 70, 75), NKSL, LVTs (68), EKSL, NKL (70, 75, 77), NKE (67, 69, 70, 74, 75, 77), NKUZ50L, NKU (67, 68, 69, 70, 75, 77), NKKi (71, 74, 75), Gillula (1966 I-O Tables).

"consumption fund" (fond potrebleniia), rather than the more familiar income identity of Y = C + I + G + (X-M). Hence, activities classed as government services in the U.S. (if they would be classified as material product) must be placed in either the consumption or accumulation fund. The

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discussed above in the section on output measures.

TABLE A.14

CPVT: PRIVATE CONSUMPTION
(millions of current rubles)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1958	**	**	**	**	**	**
1959	**	**	**	**	**	**
1960	**	**	**	**	**	**
1961	**	1356.0	771.2	**	**	**
1962	**	1447.0	817.1	2843.2	**	**
1963	**	1469.0	845.0	3138.1	**	**
1964	**	1532.0	911.4	3427.3	**	**
1965	**	1642.0	964.9	3790.8	1064.1	**
1966	**	1782.0	1027.5	4204.6	1182.9	**
1967	**	1953.0	1130.2	4617.8	1288.0	**
1968	**	2145.0	1245.2	5057.3	1374.1	**
1969	**	2290.0	1325.3	5346.8	1497.2	**
1970	**	2497.0	1438.3	5830.6	1619.9	**
1971	**	2628.0	1504.2	6414.4	1723.3	**
1972	**	2740.0	1563.6	6729.1	1820.2	**
1973	**	2831.0	1632.9	7185.2	1969.6	**
1974	**	2942.0	1699.4	7648.3	2089.9	**
1975	**	**	1766.6	**	**	**
1976	**	**	**	**	**	**
1977	**	**	**	**	**	**

Sources: NKLS, LVTs (68), EKSL, NKL (70, 75), NKE (67, 69, 70, 74, 75), NKUZ50L, NKU (67, 68, 69, 70, 75) NKKi (71, 74, 75).

following activities are included in total consumption: private consumption; material expenditures of service institutions; scientific institutions; and administration. Private consumption covers purchases from state and cooperative retail trade and from collective farm markets, products received in kind as labor payments from collective and state farms, products consumed out of private subsidiary

activities, and the value of housing stock depreciation during the period.[33] Included in the consumption fund are some of the annual military expenditures of the Soviet Union. Private consumption likely includes military subsistence, and public consumption includes material expenditures on current maintenance of the military (e. g., petroleum products and non-wage research and development); military construction and hardware are mostly in accumulation.[34]

Much of the discussion of price deflation in the section on wages applies here. The preponderance of consumption is private consumption, while public consumption is a varied lot. For the same reasons given above in the wage section, the consumption data used here are in current rubles.

Soviet Defense Expenditures.

Data on total Soviet defense expenditures are simply not available from official Soviet sources. It is necessary therefore to use western estimates as approximations. The data presented in Table A.15 were obtained by linking estimates by Robert Sishko, Defense Budget Interactions Revisited, with CIA estimates for 1967-1977, in Estimated Soviet Defense Spending: Trends and Prospects, with the splice at 1968. The series is in 1970 rubles. The

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[33]NARKHOZ 1963, p. 503, NKhLa 1970, pp. 314-315.

[34]Becker, "National Income," pp. 90-91.

definition of defense expenditure used corresponds to U. S. practice.

TABLE A.15

DF: SOVIET DEFENSE EXPENDITURES
(billions of 1970 rubles)

Year	Defense Expenditures	Year	Defense Expenditures
1958	21.8	1968	41.9
1959	23.6	1969	44.1
1960	23.4	1970	45.1
1961	29.1	1971	46.3
1962	31.9	1972	47.4
1963	35.0	1973	51.6
1964	33.4	1974	53.8
1965	32.1	1975	55.4
1966	33.6	1976	58.6
1967	36.3	1977	59.8

Sources as noted in the text.

Other Variables in Value Units.

Data for capital stock by major sector and branch of industry for the individual republics and the USSR as a whole are used in computing $PRIO_t$, along with the figures on national investment by sector and industrial branch. The major sector composition of the republic capital stocks is routinely published as part of the data on basic funds. For all years but 1960, 1961, 1967, 1976, and 1977, the industrial branch composition of capital by republic was published in the NARKHOZ series. Most of the remaining values were filled in from republic handbooks, though there

are some gaps for some republics, primarily for 1960 and 1977. In these cases, the same sector shares as for the adjacent year were assumed, on the grounds that the branch composition of capital did not change dramatically during a single year.

Data by major sector and industrial branch for the nation as a whole are published regularly in the NARKHOZ series. Data on investment in industry and its branches are available on the same basis as was used for the republics (i.e., excluding collective farm investment). However, for the other sectors of the economy data are only available over the entire period for all sources of investment, which in the productive sphere includes the collective farms. Since collective farm investment in these sectors is quite small, the distortive effect is expected to be negligible.

Data in Physical Units

Population Statistics.

A number of variables used in the model are constructed from Soviet population information. These data are in turn the product of periodic censuses; those providing the data used in this study were in 1959 and 1970. The data for intervening years is estimated by Soviet statistical agencies. On the whole, the data required here were reasonably accurate and readily available in the republic and national statistical handbooks.

TABLE A.16

POP: TOTAL POPULATION
(thousands of people)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	**	**	1184	**	**	**
1959	2711	2093	1196	8119	2066	1980
1960	2755	2113	1209	8396	2131	2044
1961	2801	2144	1222	8721	2214	2120
1962	2845	2174	1236	9069	2298	2216
1963	2881	2198	1249	9406	2369	2307
1964	2916	2227	1267	9743	2458	2394
1965	2953	2254	1284	10068	2532	2468
1966	2989	2279	1297	10399	2615	2555
1967	3026	2304	1308	10715	2696	2632
1968	3061	2324	1319	11068	2777	2715
1969	3095	2345	1334	11451	2859	2806
1970	3128	2364	1356	11800	2933	2899
1971	3165	2386	1373	12130	3001	2982
1972	3202	2409	1391	12526	3075	3093
1973	3233	2430	1405	12896	3145	3187
1974	3261	2454	1417	13289	3219	3283
1975	3289	2478	1428	13689	3298	3386
1976	3315	2497	1437	14079	3368	3485
1977	3342	2512	1447	14474	3443	3590

Sources: EKLi (75, 77), NKL (70, 76, 77), NKE (75, 77), NKU (71, 77), NKKi (71, 72, 75) KiZGSV77, NKT (65, 76).

Certain deficiencies in the data are reasonably well known.[33] Collection of the data for this study revealed some additional shortcomings of Soviet population figures. First, data at all territorial administrative levels for

[33]For a discussion of Soviet demographic statistics, see U. S., Department of Commerce, Population Projections by Age and Sex: For the Republics and Major Economic Regions of the USSR, 1970 to 2000, by Godfrey S. Baldwin, Foreign Demographics Analysis Division Series P-91, No. 26

TABLE A.17

POPU: URBAN POPULATION
(thousands of people)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	**	**	662	**	**	**
1959	1045	1114	675	2729	696	646
1960	1082	1136	690	2841	722	684
1961	1127	1175	709	3035	760	721
1962	1169	1213	736	3176	830	754
1963	1208	1247	757	3317	860	778
1964	1251	1279	776	3437	894	818
1965	1296	1312	798	3567	926	867
1966	1343	1349	814	3704	965	920
1967	1391	1380	828	3833	998	972
1968	1443	1408	843	4015	1033	1015
1969	1499	1443	859	4189	1071	1047
1970	1571	1477	881	4322	1098	1076
1971	1627	1503	900	4443	1130	1112
1972	1686	1530	920	4599	1162	1164
1973	1744	1556	937	4826	1195	1203
1974	1795	1584	954	5030	1228	1242
1975	1849	1623	968	5259	1261	1279
1976	1903	1650	982	5484	1312	1300
1977	1952	1673	995	5712	1344	1301

Sources: See Table A.16.

years prior to 1970 differed between pre-1970 and post-1970 sources, sometimes substantially. This presumably reflects efforts by Soviet statisticians to correct earlier figures based on information gained in the 1970 census. For larger administrative units (i. e., the republics) retroactive estimates allow compilation of a continuous series. However, for city populations a consistent series is not

(Washington, D. C.: Government Printing Office, 1979).

TABLE A.18

POPR: RURAL POPULATION
(thousands of people)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1958	1665	**	522	**	**	**
1959	1665	979	521	5390	1370	1334
1960	1673	977	518	5555	1409	1360
1961	1674	969	512	5686	1454	1398
1962	1676	961	499	5893	1468	1461
1963	1672	951	492	6089	1509	1529
1964	1665	948	490	6306	1564	1575
1965	1657	942	486	6501	1606	1600
1966	1646	930	482	6695	1650	1634
1967	1635	924	480	6882	1698	1659
1968	1618	916	476	7053	1744	1699
1969	1596	902	474	7262	1788	1759
1970	1556	887	474	7478	1835	1822
1971	1538	883	473	7687	1871	1869
1972	1516	879	470	7927	1913	1928
1973	1488	874	467	8070	1950	1984
1974	1466	870	463	8259	1991	2041
1975	1440	855	460	8430	2037	2107
1976	1411	847	455	8595	2056	2185
1977	1390	839	451	8762	2099	2289

Sources: See Table A.16.

readily available. Therefore, in many cases there is a much larger difference between the 1969 figure and the 1970 entry than is the case for other years.

Data for republic total, urban, and rural populations are given in Tables A.16 through A.18, and the rate of natural population increase is given in Table A.19. There are a few peculiarities about the classification of settlements as either rural or urban that require

TABLE A.19

PGR: NATURAL POPULATION INCREASE
(per thousand people)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1958	14.6	6.8	5.6	31.8	**	23.2
1959	13.7	6.0	5.7	31.1	**	24.8
1960	14.7	6.7	6.1	33.8	30.8	28.4
1961	14.3	6.6	5.9	32.5	29.1	28.9
1962	12.2	5.2	5.2	31.1	27.4	27.8
1963	11.7	5.0	4.8	30.4	27.1	28.9
1964	11.6	5.3	5.4	30.0	25.5	29.3
1965	10.2	3.8	4.1	28.8	24.9	30.2
1966	10.1	3.8	3.7	28.4	24.1	29.4
1967	9.6	3.4	3.8	27.1	23.5	28.6
1968	9.2	3.2	4.2	28.4	23.8	30.7
1969	8.7	2.9	4.2	26.9	22.6	28.6
1970	8.7	3.3	4.7	28.1	23.1	28.4
1971	9.1	3.7	5.1	29.1	24.6	31.1
1972	7.9	3.2	4.5	27.1	23.1	29.0
1973	7.0	2.4	4.0	27.3	23.0	28.4
1974	6.9	2.8	4.3	27.8	23.2	29.5
1975	6.2	1.9	3.3	27.3	22.3	29.0
1976	6.1	1.7	3.1	28.2	23.1	29.7
1977	5.7	1.4	3.3	26.6	**	27.7

Sources: NKLi (65), EKLi (70, 75, 77), NKL (70, 77), NKE (71, 74, 75, 77), SUZ401, UZ7L, NKU (67, 68, 70, 75, 77) NKKi (60, 71, 74, 75), KZGSV77, NKT 76, NARKHOZ 77.

explanation. There are two dimensions to classification: city size and economic activity. The city size criterion varies among republics, with the cut-off point ranging from a population of 10,000 to a population of 15,000. To classify as a city, a settlement must be characterized by

"primarily non-agricultural" economic activity.[36]

Labor Data.

There are three labor variables in this study: non-agricultural labor (L); agricultural labor (LA); and "skilled" (educated) labor (LS). Consider first LS. It is the number of specialists with higher and specialized middle education employed in the republic economy. The category includes all persons with diplomas or certificates of graduation from higher or middle specialized educational institutions, or "placed on the very same footing" with graduates in enterprises or institution, independent of work or employment classification.[37] This measure of labor skill would seem susceptible to managerial hiring and classification practices. To the extent that higher wages are correlated with higher education classifications, one would expect artificial upward reclassification in labor-short regions due to managerial competition for workers.

Data were not available for all years for LS, and as a consequence some observations are estimated. The method of estimation was to assume that the growth in the number of educated workers was equal for each period of a gap in the data, and fill in the missing observations by interpolation using the average growth rate. The estimation was performed separately on workers with middle specialized and on workers

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[36]NARKHOZ 1977, p. 597.

[37]NARKHOZ 1977, p. 620.

with higher education. The results are probably close to the actual figures, since the longest gap in any series was two years, and tests performed over periods where the official values are known gave results quite close to the actual values. However, the issue of hiring bias aside, this variable must be considered measured in error. These data are given in Table A.20.

TABLE A.20

LS: SKILLED (EDUCATED) LABOR
(thousands of people)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1958	**	83.0	**	**	60.0	48.1
1959	82.0	90.5	**	**	65.0	52.2
1960	92.0	99.8	60.3	239.0	72.0	57.1
1961	99.0	109.1	64.0	259.9	79.0	61.9
1962	106.0	115.9	68.0	284.8	85.0	67.6
1963	113.0	122.5	72.2	307.2	91.0	71.2
1964	124.0	130.2	77.4	334.5	99.0	76.6
1965	135.0	139.4	83.9	358.4	106.0	81.9
1966	147.0	148.8	89.4	385.9	115.0	88.4
1967	159.0	157.0	95.4	418.4	123.0	94.0
1968	178.1	165.7	101.8	453.8	134.0	99.9
1969	192.0	174.8	107.8	490.9	144.6	109.4
1970	206.0	184.3	114.2	531.1	156.0	119.7
1971	221.0	193.7	120.7	577.5	168.0	129.5
1972	236.0	203.2	127.6	628.0	182.0	140.2
1973	255.0	212.7	134.8	683.0	188.0	151.7
1974	268.0	223.4	141.7	733.7	198.0	165.0
1975	291.0	237.2	148.9	788.2	213.0	179.6
1976	310.5	250.0	157.0	830.0	**	189.0
1977	331.0	260.1	165.5	917.2	**	199.8

Sources: NARKHOZ (64), NKLi (65), EKLi (75, 77), SLZ25L, NKL (70, 72, 74, 75, 76, 77), SEZ25L, NKE (68, 74, 77), NKU (77), NKKi (63, 75) KiZGSV (70, 77), KiVTs (71) KiZ50LSV, NKT (76, 77).

Data for labor in the non-agricultural material sectors were calculated by summing data found in the NARKHOZ series under the heading "average annual number of workers and employees by branch of the national economy" (srednegodovaia chislennost' rabochikh i sluzhashchikh po otrasliam narodnogo khoziaistva). Summed were entries for sectors in the non-agricultural material sphere.

These numbers come from monthly enterprise reports, and apparently cover regular workers only, since they are based on the "average registered number of workers."[32] Therefore, people holding two jobs are in a sense undercounted. The method of calculation is to divide the number of people whose labor booklets are maintained by the enterprise, determined on a daily basis, by the number of days in the month (regardless of whether or not the plant was in operation on all those days, or of holidays). Annual figures are determined by adding the monthly values and dividing by 12, regardless of the number of months in the year the factory operated.[33] The number of average annual workers as a measure of resource use is not sensitive to certain institutional changes that hourly figures would capture. Specifically, changes in the length of the workday or workweek will not enter into the figure. Fortunately, changes of this nature were not substantial during the

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[32]NARKHOZ 1963, p. 707.

[33]Murray Feshbach, "Industrial Labor Statistics," in Treml and Hardt, Soviet Economic, pp. 198-199.

period covered by this study.[*]

As is the case with output, data are thus gathered on an organizational rather than a product classification basis. Further, maintaining the distinction between "productive" and "non-productive" sphere workers is quite difficult under these circumstances, and likely there is miscategorization; this is, for the purposes of this study, a minor problem.

For the earlier parts of the period, a number of categories of productive employment (including in particular workers in capital repair) were lumped together with a residual of employment from the non-productive sphere. The list of categories combined into this composite "other" category reveals most of them to be from the material sphere. The decision was to count this entire category as material employment. While this injects some error into the series, a check with Rapawy's much more detailed accounts for 1965 reveals it to be quite small.

More serious is the fact that for some republics in some of the early years, and all of them in 1976 and 1977, branch structure of employment data are not available, although total average annual state employment in the

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[*]A reduction of the workweek was carried out between 1956 and 1961, so that the average annual data used here may overstate the rate of increase in total labor expenditure between 1960 and 1961. See Murray Feshbach and Stephen Repawy, "Soviet Population and Manpower Trends and Policies", in Joint Economic Committee, 94th Congress, 2nd Session, Soviet Economy in a New Perspective (Washington, D. C.: Government Printing Office, 1976), pp. 134, 138.

economy is available for all years. Total state employment formed the basis for estimating the missing numbers by linear regression. As in the wage case, the regression equations gave very good fits for those years in which disaggregated data are available. Due to this estimation, the variable L must be considered measured in error. The values for L are given in Table A.21.

For labor on the state farms, the same method was followed, and indeed the data came from the same table in the statistical handbooks. Entries for sovkhoz employment cover "basic production personnel,"[41] but the data include employment of "state farms and subsidiary agricultural enterprises" (sovkhozy i podsobnye sel'skokhoziaistvennye predpriiatiia). They thus contain workers who are not properly employed in agriculture.[42] The Latvian statistical administration published data on sovkhoz workers in agriculture, strictly defined, for recent years. These data show, e. g., for 1970, that 88 per cent of sovkhoz employment works in agriculture, per se.[43] However, this measure is not consistently available for econometric modeling.

Data on employment on collective farms is available for the entire period in the republic or national statistical

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[41]NARKHOZ 1963, p. 707.

[42]Eberhardt Schinke, "Soviet Agricultural Statistics," in Treml and Hardt, Soviet Economic, pp. 254-255.

[43]NKL, 1970, p. 230.

TABLE A.21

L: LABOR (NON-AGRICULTURAL)
(thousands of workers)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	353.6	432.0	264.5	654.4	**	173.0
1959	387.6	456.0	286.1	689.1	**	175.0
1960	416.5	500.0	301.6	793.6	245.0	188.0
1961	458.4	523.0	320.8	847.7	265.0	203.0
1962	485.4	548.0	331.7	881.6	280.0	217.0
1963	512.5	571.0	347.3	921.7	297.0	227.0
1964	548.0	593.0	362.3	977.8	313.0	242.0
1965	590.8	621.0	379.3	1100.4	338.0	263.0
1966	629.7	644.0	390.1	1122.1	361.0	*277.0
1967	667.8	666.0	399.7	1194.4	383.0	292.0
1968	708.2	690.0	410.8	1255.6	407.0	*306.0
1969	743.0	702.0	416.7	1301.7	426.0	317.0
1970	769.3	706.0	423.6	1406.4	463.0	331.0
1971	792.3	716.0	428.9	1463.3	481.0	346.0
1972	813.8	724.0	433.7	1515.9	494.0	360.0
1973	832.8	733.0	438.0	1579.7	508.0	374.0
1974	852.5	743.0	442.3	1635.5	525.0	389.0
1975	873.3	752.0	446.2	1705.5	541.0	405.0
1976	*894.3	*760.0	*458.1	*1798.5	*562.0	*422.0
1977	*912.1	*767.0	*463.4	*1856.7	**	**

Sources: NARKHOZ (61, 62, 63, 64, 65, 66, 68, 69), NKLi, (65) EKLi (70, 75, 77), LVTs (65, 68, 69), SEZ25L, NKE (69, 72, 74, 75, 77), UZ7L (59-65), SUZ50L, NKU (67, 68, 70, 75, 77), KiZ50LSV, KiZGSV70/77, NKKi (71, 72, 75), Rapawy, "Regional Employment Trends."

handbooks. The figures used here come from table entries titled "average annual number of collective farm members who have participated in the work of the collectives" (srednegodovaia chislennost' kolkhoznikov, prinimavshsikh uchastie v rabotakh kolkhozov). The data exclude fishing collectives. Monthly values are calculated from the kolkhoz

wage rolls by simply counting all the members of the collective that have shown up for work in the socialized sector in a given month, regardless of how much work they put in. The monthly totals for the entire year are averaged to arrive at the published figure. Further, due to the seasonal nature of the work, during peak months auxiliaries are often brought in from the outside.[46]

A considerable number of workers on collective farms are engaged in non-agricultural activities; in Latvia in 1970 agricultural workers amounted to about 80 per cent of total kolkhoz employment.[47] Again, however, data on agricultural workers strictly defined were not available on a wide enough basis for econometric use.

Total agricultural labor was obtained by summing the values for sovkhoz employment with the values for kolkhoz employment. These totals are presented in Table A.22.

Urban Housing.

The Soviet statistical administration regularly publishes data on housing in two forms: total value of the housing stock, given as a part of non-productive basic funds; and by urban "total useful area" (obshchiaia [poleznaia] ploshchad'). Unfortunately, neither rural housing availability nor total housing availability by floor space is published for the republics covered in this study,

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[46]Schinke, "Soviet Agricultural," p. 253.

[47]NKL 1970, p. 230.

TABLE A.22

LA: LABOR (SOCIALIZED AGRICULTURE)
(thousands of workers)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	**	**	**	**	**	**
1959	**	**	**	**	**	**
1960	484	290	146	1287	279	318
1961	474	290	136	1266	274	313
1962	467	283	134	1282	289	316
1963	461	273	128	1318	301	324
1964	443	259	127	1320	307	319
1965	451	269	126	1343	315	317
1966	457	262	124	1354	313	313
1967	458	258	123	1349	319	306
1968	454	253	120	1366	317	308
1969	440	235	113	1392	316	313
1970	429	254	109	1428	319	321
1971	421	236	107	1442	324	333
1972	415	233	104	1478	324	336
1973	405	232	103	1508	326	338
1974	398	227	101	1551	337	347
1975	385	221	105	1586	334	355
1976	380	222	104	1620	348	364
1977	370	223	104	1634	**	364

Sources: NARKHOZ, 1960-1977.

except for Latvia for 1968 and 1970 and thereafter. The "useful area" turns out to exaggerate the actual living space, since it includes all living and auxiliary rooms of apartment buildings and hostels "including kitchens, hallways, and the like."[‘‘] Urban housing area is given in Table A.23.

[‘‘] NARKHOZ 1977, p. 621, and NARKHOZ 1963, p. 711.

TABLE A.23

HU: URBAN HOUSING
(millions of square meters)

Year	THE BALTIC			CENTRAL ASIA		
	Lithuania	Latvia	Estonia	Uzbekistan	Kirgizia	Tadzhikistan
1958	**	**	**	**	**	**
1959	9.8	14.1	7.4	20.5	4.9	5.0
1960	10.3	14.5	7.7	22.1	5.4	5.4
1961	10.6	15.0	8.1	23.7	5.7	5.7
1962	11.1	15.7	8.6	24.9	6.4	6.0
1963	11.7	16.2	9.1	26.0	6.8	6.3
1964	12.4	16.7	9.5	27.2	7.1	6.7
1965	13.1	17.3	9.9	28.5	7.5	7.1
1966	13.8	17.8	10.2	29.4	7.9	7.5
1967	14.6	18.4	10.6	28.3	8.2	8.0
1968	15.5	19.0	10.9	30.8	8.6	8.5
1969	16.2	19.6	11.3	32.6	9.1	9.0
1970	17.3	20.3	11.8	34.4	9.5	9.2
1971	18.4	20.9	12.3	35.9	9.9	9.8
1972	19.4	21.5	12.8	37.8	10.4	10.3
1973	20.6	22.2	13.3	40.3	10.9	10.7
1974	21.7	22.9	13.8	42.8	11.3	11.2
1975	22.8	23.7	14.3	46.7	11.7	11.6
1976	23.9	24.5	14.5	48.8	12.2	11.9
1977	25.0	25.1	15.0	51.2	12.5	12.1

Sources: NARKHOZ (60, 62, 63, 64, 69, 75,77), EKLi (69, 70, 75, 77) LVTs (68), NKSL (68), NKL (73), SEZ25L, NKE (69, 72, 74), NKU (65, 67, 68, 70, 75, 77), KiZGSV70/77, NKKi (71, 72, 75).

Land Under Cultivation.

The measure chosen for agriculturally cultivated land (TR) is the "entire sown area" (vsia posevnaia ploshchad'). This is the productive area, recorded at the end of spring sowing, including secondary row crops sown between and under fruit trees, and first seedings on pastures that have been

TABLE A.24

TR: AGRICULTURAL SOWN AREA
(thousands of hectares)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1958	2218	1460	**	**	1231	747
1959	2340	1515	**	**	1196	738
1960	2375	1534	762	3038	1195	724
1961	2456	1596	783	3174	1206	762
1962	2452	1594	788	3223	1226	757
1963	2407	1584	783	3335	1236	759
1964	2439	1562	777	3545	1245	772
1965	2440	1556	772	3336	1170	764
1966	2344	1526	752	3353	1250	765
1967	2344	1525	759	3315	1236	747
1968	2320	1531	774	3495	1262	747
1969	2337	1530	782	3480	1250	720
1970	2286	1541	798	3476	1264	764
1971	2328	1541	840	3437	1253	708
1972	2356	1574	866	3505	1275	753
1973	2353	1582	890	3561	1311	702
1974	2370	1594	927	3601	1288	722
1975	2375	1602	933	3723	1246	702
1976	2372	1611	945	3745	1282	774
1977	2387	1633	951	3818	0	718

Sources: Bond, p. 221, NKLi (65), EKLi (75, 77), SLZ25L, LVTs (61, 68, 69), NKL (75, 76, 77), SEZ25L, NKE (69, 70, 74, 75, 77), NKU (77), KiZ50LSV, KiZGSV77, NKKi(61, 63, 71, 75) NKT (62, 65, 69, 72, 77).

plowed up, but not underseeds in annual crops.'' However, due to the workings of the incentive system, over-plan seedings are sometimes undertaken and not reported, in order to raise yields. However, fear of increased quotas must limit this practice to hedges against disasters. While the

''Ibid., p. 242; NARKHOZ 1977, p. 611.

reporting system for recording crop plantings is detailed and complicated, the official data may understate actual sowings. These data are given in Table A.24.

Irrigated Land.

TABLE A.25

IRRI: IRRIGATED LAND
(thousands of hectares)

Year	CENTRAL ASIA		
	Uzbekistan	Kirgizia	Tadzhikistan
1958	**	**	**
1959	**	**	**
1960	2474	854	387
1961	2521	865	402
1962	2568	875	418
1963	2618	875	418
1964	2667	831	429
1965	2518	840	437
1966	2568	862	456
1967	2601	859	473
1968	2638	866	478
1969	2651	870	484
1970	2623	876	498
1971	2704	883	509
1972	2758	889	520
1973	2821	896	533
1974	2905	901	544
1975	2984	901	556
1976	3058	916	570
1977	3165	925	582

Sources: NARKHOZ (63, 64, 74, 77), SUZ40L, SUZ50L, UZ7L (59-65) NKU (68, 69, 75, 77), KiZ50LSV, KiZGSV70/77, NKKi (67, 71, 75), STZ50L, NKT (69, 72, 76, 77).

Irrigated land (a factor only for Central Asia) is defined as land having a continuous irrigation net,

connected with a source of irrigation water. The specific measure chosen here is "total utilized irrigated agricultural land" (vse ispol'zovano oroshaemoe sel'skokhoziaistvennoe ugod'e).[48] The tables in the handbooks suggest that this figure differs from total available irrigated land by "land in short-term use" (zemlia kratkosrochnogo pol'zovaniia).[49] The percentage of irrigated land in short-term use has diminished remarkably in recent years.[50] The data used are given in table A.25; data for years not found in Soviet sources were filled in by moving averages for Uzbekistan, and averaging rates of growth from 1957 for Kirgizia and Tadzhikistan.

Fertilizer.

Data on deliveries of mineral fertilizer to agriculture (postavka mineral'nykh udobrennii sel'skomu khoziaistvu), measured in tons, is available in the handbooks. While data on deliveries of fertilizer are considered accurate, utilization in agriculture is not uniform. Specifically, there is a difference between what is delivered and what is timely and accurately applied. Further, irregularities in farm methods of accounting for fertilizer have been noted.[51] This raises the possibility of fertilizer being delivered to

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[48]NARKHOZ 1977, P. 612.

[49]See, e. g., NARKHOZ 1977, p. 249.

[50]For an example, see STZ50L, p. 119.

[51]NARKHOZ 1977, p. 617.

TABLE A.26

FERT: FERTILIZER DELIVERIES
TO AGRICULTURE
(thousands of tons)

Year	THE BALTIC			CENTRAL ASIA		
	Lith-uania	Latvia	Estonia	Uzbek-istan	Kirgizia	Tadzhik-istan
1958	559	448	293	**	169	315
1959	565	435	**	**	170	311
1960	586	441	301	1721	177	312
1961	595	517	*317	*1784	181	267
1962	659	524	333	1847	200	299
1963	725	559	351	2117	241	357
1964	852	656	406	2257	296	429
1965	983	758	469	2548	397	479
1966	1011	853	471	2705	453	514
1967	1116	923	493	3205	458	538
1968	1120	1004	555	3047	533	646
1969	1126	977	578	3289	541	632
1970	1429	1205	672	3479	645	674
1971	1501	1144	706	3666	704	763
1972	1630	1195	729	3811	792	832
1973	1706	1206	769	3842	764	817
1974	1850	1271	773	3766	834	814
1975	1994	1387	908	4375	905	863
1976	1990	1456	933	4508	945	866
1977	2083	1476	958	4820	**	889

Sources: NARKHOZ (63, 65), NKLi (65), EKLi (70, 75, 77), EKSL (66), NKSL (68), SLVTs, LVTs (68), NKL (70, 75, 77), SEZ25L, NKE (69, 72, 74, 75, 77), NKU (65, 67, 68, 70, 75, 77), KiZ50LSV, KiZGSV70/77, NKKi (61, 72, 74, 75), STZ50L, NKT (64, 69, 72, 75, 76, 77).

the socialized sector but actually winding up in the private sector. Data on fertilizer deliveries are given in Table A.26.

Weather Indexes.

The two variables included in the equation for agricultural output are indexes measuring the relative amount of precipitation (RAIN) and the relative temperature (TEMP). The source of the basic data used in constructing these indexes is Monthly Climatic Data for the World, published by the U. S. Department of Commerce, Environmental Data Service (formerly the U. S. Weather Bureau) in cooperation with the World Meterological Organization. The data used are surface temperature (monthly average) and total monthly precipitation. However, not all stations reported all data for all months, and it was therefore necessary to establish a procedure to average the available information.

Further, the crops, their planting times, and basic methods of cultivation vary drastically between the Baltic and Central Asia, and the significant weather hazards are different for the two regions. Consequently, different coverages were used in constructing the weather variables for the two regions. All weather indexes, however, were measured as deviations from the mean. In Central Asia, reports from the Tashkent station were used to construct all indexes. For the Baltic, reports from the Tallin and Kaunas stations were averaged, weighted equally.

The single site of Tashkent was chosen because of its proximity to many of the major farming areas of Central Asia (e. g., the Fergana valley), and also because of actual agricultural practices in the region. Cultivated areas in

the desert portions of the region depend on irrigation out of rivers having their sources in the mountains near Tashkent. Consequently, precipitation measured at the Tashkent station may be more relevant than precipitation at actual farm sites, but less adequate than a station in the mountains where the river headwaters are.

For Central Asia, two measures for RAIN were calculated: relative precipitation during the actual growing season; and total rainfall over the year preceding the harvest. Since there is virtually no dependable rainfall from July until the end of the harvest season, the growing season rainfall index was calculated based on relative total precipitation from March through June. Further, since September is the principal harvest month in the region, relative annual precipitation was measured from October of the preceding year through September of the current year. Drought as a weather hazard is partially captured in both of these rainfall indexes.[52]

The weather hazard aspect dominated the choice of temperature measures, both for Central Asia and the Baltic. For Central Asia, since wintering conditions are on the whole favorable, the relevant problems are drought and/or hot, dry, desiccating winds called sukhovei. Consequently, TEMP is the relative temperature during the growing season.

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[52]A source of information on crop composition, growing seasons, and relevant weather hazards is U. S., Central Intelligence Agency, USSR Agriculture Atlas, December, 1974, pp. 12-13, 19.

Two measures were again tried here: temperature deviation from May through August and temperature deviation from May through Septembe:.

For the Baltic, since the bulk of precipitation falls during the growing season, the precipitation index is calculated from relative total rainfall from April through August. The relevant temperature hazard for the Baltic is a harsh winter and/or a cold spring. Consequently, two temperature hazard measures were tried: relative temperature from March through May (the sowing and sprouting period); and relative temperature from November through May (to capture the effects of a harsh winter on the winter grain crops).

The method for calculating the weather indexes was to find first the average temperature, average precipitation, and standard deviations of the measured precipitation and temperature for the three stations from 1958 through 1977. To find the average total values for a seasonal period, the monthly averages for each station were summed over that period. The relative value of the index for any particular year is then the difference between the sum of the reported monthly values for the period in that year and the over-all average value.

For missing months, that month's average was subtracted from the average total, and the value used in the index is the difference between the observed and the shortened "average" period. In the case of the Baltic, when one

station reported a measure for a given month and the other did not, then the deviation between the average and current value for the reporting station was used for the region as a whole. This procedure was used because while there are systematic differences between the values reported for Tallin and Kaunas, they both tend to deviate from the norm in the same direction and by about the same amount in a given month. Further, while the average values are different between the two stations, the standard deviations of the observed values of both temperature and precipitation are quite similar. Hence, the magnitude of a deviation from the norm at one station is apt to be about the same as the magnitude of the deviation at the other.

APPENDIX B

ECONOMETRIC TECHNIQUES

There are three objectives to be accomplished in this appendix. First, it will be shown that, for estimation of a single equation in a simultaneous system, IV estimation gives consistent results when there are errors in the variables. Second, a method of determining if a single equation in an errors-in-variables simultaneous system is identified will be developed. Third, some statistical problems associated with time-variable parameters will be discussed, and a solution suggested.

Instrumental Variables estimation of Errors-in-Variables Systems.

Consider a simple two-equation system, written

$$(B1.a) \quad Y_{1,t} = \alpha_0 + \alpha_1 Y_{2,t} + \alpha_2 X_{1,t} + \varepsilon_{1,t}$$

$$(B1.b) \quad Y_{2,t} = \alpha_0 + \alpha_1 Y_{1,t} + \alpha_2 X_{2,t} + \alpha_3 X_{3,t} + \varepsilon_{2,t}.$$

Suppose that $Y_{2,t}$ and $X_{1,t}$ are not observed, but instead $Y^*_{2,t}$ and $X^*_{1,t}$, related to $Y_{2,t}$ and $X_{1,t}$ by

$$Y^*_{2,t} = Y_{2,t} + \delta_{Y,t}$$

$$X^*_{1,t} = X_{1,t} + \delta_{X,t}$$

where δ_Y and δ_X are random variables with zero means, assumed uncorrelated with any other variables in the system.

The reduced form of equation system (B1) is

$$(B1.a1)\quad Y_{1,t} = \pi_{0,1} + \pi_{1,1}X_{1,t} + \pi_{2,1}X_{2,t} + \pi_{3,1}X_{3,t} + u_{1,t}$$

$$(B1.b1)\quad Y_{2,t} = \pi_{0,2} + \pi_{1,2}X_{1,t} + \pi_{2,2}X_{2,t} + \pi_{3,2}X_{3,t} + u_{2,t}$$

where $u_{1,t} = 1/(1-\beta_1\alpha_1)[\varepsilon_{1,t} + \alpha_1\varepsilon_{2,t}]$ and $u_{2,t} = 1/(1-\alpha_1\beta_1)[\varepsilon_{2,t} + \beta_1\varepsilon_{1,t}]$.

Since $Y_{2,t}$ and $X_{1,t}$ are not observed, but rather $Y^*_{2,t}$ and $X^*_{1,t}$, equation B1.a can be written as

$$(B1.a2)\quad Y_{1,t} = \alpha_0 + \alpha_1 Y_{2,t} + \alpha_2 X_{1,t} + (\varepsilon_{1,t} + \alpha_1\delta_{Y,t} + \alpha_2\delta_{X,t}).$$

This can be expressed in vector notation as

$$Y_1 = [\iota,\ Y_2,\ X_1]\begin{bmatrix}\alpha_0\\ \alpha_1\\ \alpha_2\end{bmatrix} + [\varepsilon_1,\ \delta_Y,\ \delta_X]\begin{bmatrix}1\\ \alpha_1\\ \alpha_2\end{bmatrix},$$

where ι is a T by one vector of ones, Y_1, Y_2, X_1, ε_1, δ_Y, and δ_X are all dimension T by one. Ordinary least squares estimation gives

$$(B1.a3)\quad \hat{\alpha} = \left[\begin{bmatrix} \iota' \\ Y_2^{*\prime} \\ X_1^{*\prime} \end{bmatrix} [\iota,\ Y_2,\ X_1]\right]^{-1} \begin{bmatrix} \iota' \\ Y_2^{*\prime} \\ X_1^{*\prime} \end{bmatrix} [Y_1]$$

$$= \left[\begin{bmatrix} \iota' \\ Y_2^{*\prime} \\ X_1^{*\prime} \end{bmatrix} [\iota,\ Y_2,\ X_1]\right]^{-1} \begin{bmatrix} \iota' \\ Y_2^{*\prime} \\ X_1^{*\prime} \end{bmatrix} \cdot$$

$$\left[[\iota,\ Y_2,\ X_1] \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \end{bmatrix} + [\varepsilon_1,\ \delta_Y,\ \delta_X] \begin{bmatrix} 1 \\ \alpha_1 \\ \alpha_2 \end{bmatrix}\right]$$

$$= \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \end{bmatrix} + Q^{-1} \begin{bmatrix} \iota' \\ Y_2^{*\prime} \\ X_1^{*\prime} \end{bmatrix} [\varepsilon_1,\ \delta_Y,\ \delta_X] \begin{bmatrix} 1 \\ \alpha_1 \\ \alpha_2 \end{bmatrix}$$

where Q^{-1} is implicitly defined. Clearly, plim $(\hat{\alpha})$ is not α, where $\hat{\alpha} = [\hat{\alpha}_0, \hat{\alpha}_1, \hat{\alpha}_2]'$, since Y_2^* is correlated with ε_1, as shown above in equation (B1.a1) (simultaneity bias), and Y_2^* is correlated with δ_Y and X_1^* is correlated with δ_X (the errors-in-variables problem). Note that both sources of inconsistency are due to contemporaneous correlation between explanatory variables and the equation composite error term.

Suppose, however, that Y_2^* and X_1^* are regressed on X_2

and X_3, in the form

$$Y^*_{2,t} = \gamma_{Y,0} + \gamma_{Y,2}X_{2,t} + \gamma_{Y,3}X_{3,t} + \eta_{Y,t}$$

$$X^*_{1,t} = \gamma_{X,0} + \gamma_{X,2}X_{2,t} + \gamma_{X,3}X_{3,t} + \eta_{X,t}$$

or

$$Y_{2,t} = \gamma_{Y,0} + \gamma_{Y,2}X_{2,t} + \gamma_{Y,3}X_{3,t} + (\eta_{Y,t} - \delta_{Y,t})$$

$$X_{1,t} = \gamma_{X,0} + \gamma_{X,2}X_{2,t} + \gamma_{X,3}X_{3,t} + (\eta_{X,t} - \delta_{X,t})$$

where η_Y includes, among other things, u_2. Consider $\hat{Y}_2$ and $\hat{X}_1$, vectors of fitted values from OLS estimation. By the properties of ordinary least squares, $\hat{Y}_2$ is orthogonal to δ_Y and η_Y, and $\hat{X}_1$ is orthogonal to η_X and δ_X. Therefore, $\hat{Y}_2$ and $\hat{X}_1$ are suitable instruments for Y^*_2 and X^*_1, respectively.[33] Instrumental variable estimation of the parameters of (B1.b) gives

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[33]The desirable properties of an instrument are that it be highly correlated with the variable for which it is an instrument, and independent of the (composite) error term. See Jan Kmenta, Elements of Econometrics (New York): Macmillan, 1971), pp. 309-310.

$$\alpha^{+} = \left[\begin{bmatrix} \iota' \\ \hat{Y}_2' \\ \hat{X}_1' \end{bmatrix} [\iota, Y_2, X_1]\right]^{-1} \begin{bmatrix} \iota' \\ \hat{Y}_2' \\ \hat{X}_1' \end{bmatrix} [Y_1]$$

$$= \left[\begin{bmatrix} \iota' \\ \hat{Y}_2' \\ \hat{X}_1' \end{bmatrix} [\iota, Y_2, X_1]\right]^{-1} \begin{bmatrix} \iota' \\ \hat{Y}_2' \\ \hat{X}_1' \end{bmatrix} \cdot$$

$$\left[[\iota, Y_2, X_1] \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \end{bmatrix} + [\varepsilon_1, \delta_Y, \delta_X] \begin{bmatrix} 1 \\ \alpha_1 \\ \alpha_2 \end{bmatrix}\right]$$

$$= \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \end{bmatrix} + \left[\begin{bmatrix} \iota' \\ \hat{Y}_2' \\ \hat{X}_1' \end{bmatrix} [\iota, Y_2, X_1]\right]^{-1} \begin{bmatrix} \iota' \\ \hat{Y}_2' \\ \hat{X}_1' \end{bmatrix} [\varepsilon_1, \delta_Y, \delta_X] \begin{bmatrix} 1 \\ \alpha_1 \\ \alpha_2 \end{bmatrix}$$

and the probability limit of α^{+} is α.[54]

The conclusion is that consistent estimatation of an equation in a simultaneous system that contains errors in the explanatory variables (whether they are endogenous or predetermined) can be obtained, using instruments constructed from the correctly measured system predetermined variables, provided the equation is identified taking into

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[54]Ibid., pp. 310-311.

account the errors-in-variables problem.

Parameter Identification in an Errors-in-Variables Simultaneous System

In a larger system, Identification is not easily determined, and particularly not if some of the predetermined variables are measured in error. It was shown above that IV estimation provides consistent estimation in the presence of measurement errors, whether they occur in endogenous or predetermined variables. However, to estimate equation (B1.a), a degree of conditional overidentification (conditional on there being no predetermined variable measured in error) was necessary. The objective of this section is to determine if there is sufficient information within a system for estimation, in the presence of errors in the predetermined variables (measurement error is purged from the endogenous variables in the same process that removes simultaneity bias, and so does not present an additional problem).

Consider a more general system,[88]

$$(B.2) \qquad By = \Gamma X + u$$

where y is G by one, X is K by one, u is G by one, B is G

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[88]The development of the problem that follows is largely taken from Vincent J. Geraci, "Identification of Simultaneous Equation Models with Measurement Error," Journal of Econometrics 4 (January, 1976), pp. 263-283.

by G, and Γ is G by K. The vector X is not observed, but rather X^*, related to X by

$$
\begin{aligned}
x_1^* &= x_1 + \delta_1 \\
x_2^* &= x_2 + \delta_2 \\
&\vdots \\
x_K^* &= x_K + \delta_K
\end{aligned}
$$

where some of the K elements δ_k are zero. Let all variables be measured as deviations from their means, and let there be the following stochastic assumptions:

$E(u) = 0$	$E(uu') = \Sigma_{uu}$ non-singular
$E(X) = 0$	$E(XX') = \Sigma_{XX}$ non-singular
$E(uX') = 0$	$E(\delta\delta') = \Sigma_{\delta\delta}$ diagonal and singular
$E(\delta X') = 0$	$E(\delta u') = 0$.

Geraci shows that equation identification status can be determined by first determining identification in the conventional fashion (i. e., as if variable measurement were not a problem), and then ascertaining if there is enough information, distributed in the right fashion, to allow compensation for the measurement errors. That is, if L of the K variables X are measured in error, does the system have enough information in it to allow estimation of the L non-zero elements of $\Sigma_{\delta\delta}$ as well as the structural parameters of the system.

Let R_g be the number of coefficient restrictions in the gth equation (a normalization on y_g and zeroes for variables not present in the gth equation), and let $R = \sum_{g=1}^{G} R_g$ be the total number of coefficient restrictions in the system. For example, considering the system B1, $R_a = 3$ and $R_b = 2$. Further, let L_g be the number of erroneously-measured exogenous variables in equation g.

According to Geraci,[16] the conditions required for identification are "...order ($R-G^2 \geq L$) and variety ($R_g - G \geq L_g$ for all g)." Identification by this standard boils down to determining if each equation meets the rank and order conditions for identification conditional on all the exogenous variables being correctly measured, with at least one degree of conditional over-identification for each exogenous variable measured in error that is included in that equation. For the instrumental variables method as actually applied in estimating the model above, this is a necessary condition, since otherwise one would not have enough correctly measured pre-determined variables in the system to construct an instrument for all the endogenous variables in an equation, plus an instrument for each of the mis-measured predetermined variables.

However, elsewhere in the same article Geraci implies that in general the condition that $R_g - G \geq L_g$ for all g is too restrictive.[17] Consider the two-equation system

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[16] Ibid., p. 276.

[17] Ibid., pp. 271-275.

$$\text{(B2.a)} \quad y_1 = \beta_{12}y_2 + \gamma_{11}x_1^* + \gamma_{14}x_4 + u_1 \qquad (1)$$

$$\text{(B2.b)} \quad y_2 = \beta_{21}y_1 + \gamma_{21}x_1^* + \gamma_{22}x_2 + \gamma_{23}x_3 + u_2 \qquad (0)$$

where the degree of conditional overidentification is given in parentheses following each equation, and x_1^* is an erroneously measured variable. Note that by the condition $R_g - G \geq L_g$, equation B2.b is underidentified ($R_g=2$, $G=2$, $L_g=1$), and equation B2.a is exactly identified.

However, by the method of moments both (B2.a) and (B2.b) can be estimated consistently; this is accomplished by estimating σ_1^2 (the variance of the measurement error on x_1) along with the structural parameters of equation (B2.a), and then carrying that estimate to (B2.b), and using it to gain consistent estimation of all the structural parameters there.

In general, the necessary conditions for identification of a system equation, as Geraci suggests, can be determined by using Hall's Theorem:[88]

> Let $S_1, S_2, \ldots, S_L$ be a collection of subsets of a set S. A necessary and sufficient condition for this collection to have a system of distinct representatives is that every union of k sets of the collection must contain at least k elements, for $k=1,2,\ldots,L$.

For the problem here, let S denote the set of conditionally-overidentifying restrictions in the model, and let S_1

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[88]Ibid., p. 275.

(l=1,2,...,L) denote the subset of conditionally-overidentifying restrictions for all those structural relations in which the erroneously measured variable x_1^* appears. Applying Hall's Theorem then gives a proposition:[8]

> The model as a whole is identified if and only if for each set of k unobserved [erroneously measured] variables (k=1,2,...,L), the union of the corresponding subsets $\{S_l\}$ contain at least k distinct conditionally-overidentifying restrictions.

By applying this proposition to equation system B2, one can see that for k=1 (i. e., the set of all conditionally-overidentifying restrictions for the equations in which x_1^* appears), there is one restriction, and in this simple example L=1.

Hence, the requirement that $R_g - G \geq L_g$ for all g is in general too restrictive, as shown by counter-example. However, for single-equation estimation by IV procedures, $R_g - G \geq L_g$ must hold, unless the system is implicitly extended to create suitable instruments for the erroneously measured predetermined variables.

The Geraci article addresses identification for a contemporaneous system. Clearly lagged exogenous variables are no additional problem, providing the other classical assumptions are met. Considering lagged endogenous variables, they are not in general contemporaneously correlated with the error terms in the equations in which

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[8]Ibid.

they appear (so long as the classical assumptions hold). Therefore measurement errors affecting lagged endogenous variables may in general be treated in the same fashion as any other predetermined variable.

APPENDIX C

AGGLOMERATIVE POTENTIAL

Agglomerative potential as used in this model refers to regional potential for the growth of joint factor productivity; this potential may or may not be realized. There are two basic components to any measure of agglomerative potential: agglomerative, or economizing, elements; and frictive, or barrier, elements. The barrier element used here is distance.

A time series on the population of cities that exceeded 200,000 inhabitants (100,000 for the Baltic and Central Asia) on 1 January 1977 weighted by graph-theoretically determined weights based on rail net connections provides the raw data for computing the agglomerative element. Choice of city population is forced by lack of more direct measures of potential for productivity increases. The measure proposed here should capture opportunities for economies external to individual plants. For example, the net value of industrial output by city, along with commodity flows and their composition, would be better indicators of relative opportunities for economic specialization, pooling of special skills, the development of extra-enterprise specialty operations, and organizational economies. Unfortunately, these measures are not part of the regularly published regional data in the Soviet Union. City size has

been selected as the best available alternative, primarily because it is known to be associated with productivity.[40]

The rationale for the action of economies of agglomeration within the Soviet economy is given above in Chapter II, along with a generalized definition of the term. This appendix is an elaboration of the method used to calculate a measure of A_t for use in the model.

The functional form of A_t must be such that $\partial A_t / \partial AGG_{j,t} > 0$ and $\partial A_t / \partial D_{i,t} < 0$, where $AGG_{j,t}$ is the jth of J agglomerative elements and $D_{i,t}$ is the ith of I frictive elements; I does not necessarily equal J. The functional form used here is basically a gravity model; it has been shown that the theoretic basis for potential models of the gravity type exists independent of analogies to Newtonian physics.[41] Mathematically, the functional form used here meets the conditions outlined by Sheppard to be consistent with the generalized form of mathematical potential, with one special case noted below.[42]

Spatial analysis in this model is complicated by the enormous size of the Soviet Union, and the macro-, rather than micro-, geographic nature of the problem. The

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[40]Vsevolod Holubnychy, "Spatial Efficiency in the Soviet Economy," in V. N. Bandera and Z. L. Melnyk, eds., The Soviet Economy in Regional Perspective (New York: Praeger, 1973), pp. 29.

[41]Eric S. Sheppard, "Geographic Potentials," Annals of the American Association of Geographers 69 (September 1979), pp. 438-447.

[42]Ibid., pp. 440-441.

potential model is generally presented as the interaction of a set of points in space (cities, centers of economic activity, etc.) on one another. The total potential at any point in the set is therefore the total interaction between that point and all other points in the set, exclusive of itself. The complicating problem is that here the foci of analysis are regions, containing several such points (cities), interacting with other regions, all of which contain several points (cities). Therefore, for this problem the source of agglomerative potential is the development of regional urban population concentrations and the accompanying technical/industrial concentrations.

Computation of a measure for A_t proceeds in two steps. First, an index of effective urban concentration (EUC) is developed for each region, expressed as a hypothetical population concentration at a point in an X,Y coordinate system.[1] Second, the agglomerative potential for the Baltic and Central Asia is then calculated, using the EUC values for 18 Soviet macroregions.[2]

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[1]The X,Y coordinates used in this study were established by digitizing the coordinates of the individual cities involved. All other coordinates are derived from manipulation of the city data. The map used in the digitizing process came from U. S., Central Intelligence Agency, Status of Railroads in the USSR, 1 April 1976 (Washington, D. C.: Government Printing Office, 1976) and is a Lambert Conformal Conic Projection, with standard parallels of 47 degrees and 62 degrees north. This map afforded the best combination of projection, scale, and detail available.

[2]The Soviet Union has been divided into 18 macroregions plus the republic of Moldavia by the Academy of Sciences. Since Moldavia was not officially an economic

The first step in the computational process is to establish an index for the effective urban concentration for each region in the Soviet Union. The computational scheme is

$$EUC_i = \sum_{k=1}^{K_i} POPC_{i,k}/d_{i,k}^{a}$$

where EUC_i is the effective urban concentration of the ith region, K_i is the number of above-threshold cities in the ith region, $POPC_{i,k}$ is the population of the kth city in the ith region, $d_{i,k}$ is the distance between the urban center of mass and the kth city in region i, and a is a parameter to be determined. For this and the discussion that follows, let the time subscript t be understood, and omitted for notational simplicity.

The urban center of mass for region i is calculated as

$$UCM_i = \begin{bmatrix} \sum_{k=1}^{K_i}[(rcw_{i,k} \cdot POPC_{i,k})/(\sum_{k=1}^{K_i} rcw_{i,k} \cdot POPC_{i,k})] \cdot X_{i,k} \\ \sum_{k=1}^{K_i}[(rcw_{i,k} \cdot POPC_{i,k})/(\sum_{k=1}^{K_i} rcw_{i,k} \cdot POPC_{i,k})] \cdot Y_{i,k} \end{bmatrix}$$

where UCM_i is the two-dimensional vector of X,Y coordinates

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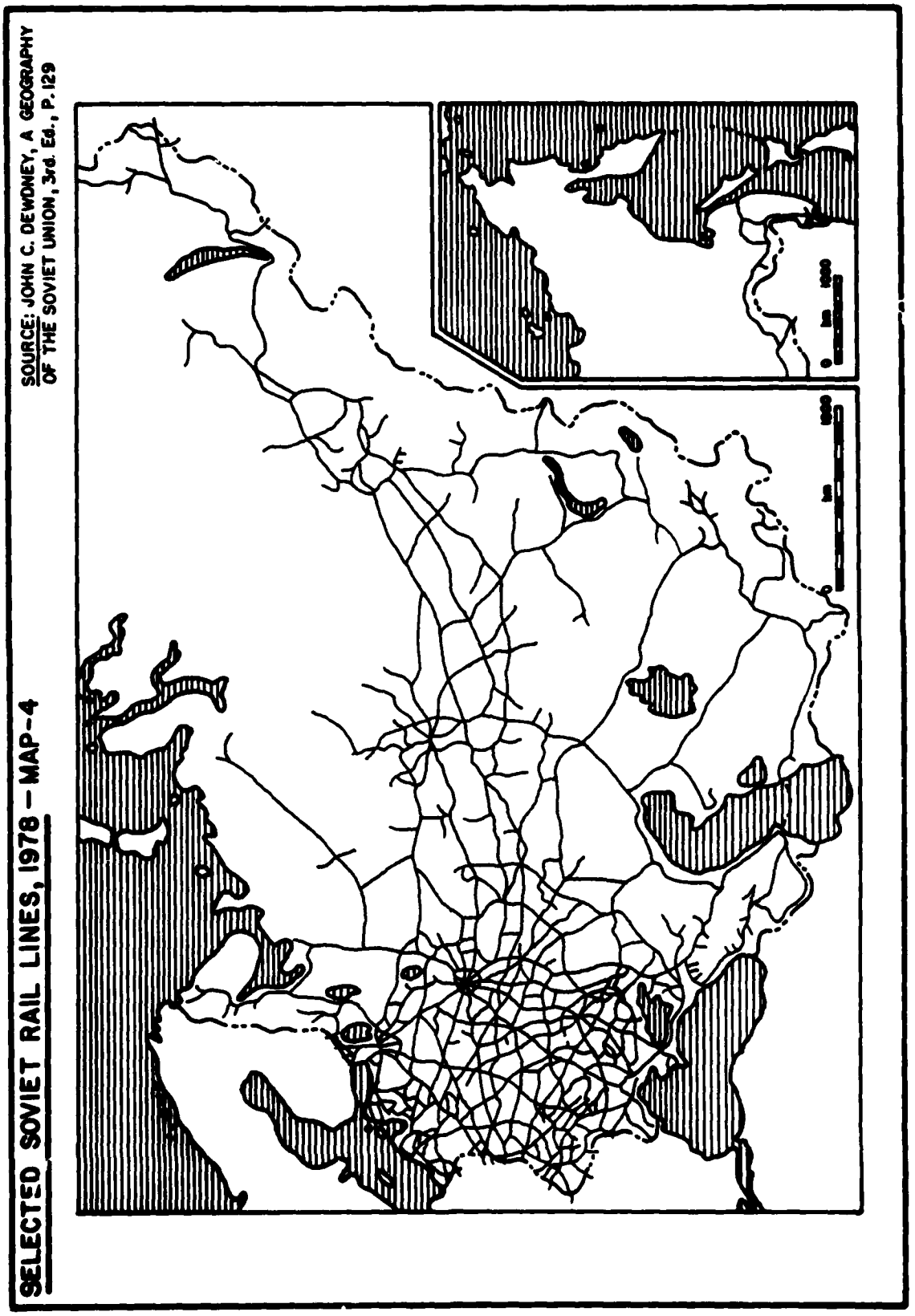
region during the period of this study, and contained only one city over the threshold size, it was combined with the South region of the Ukraine for computation of agglomerative potential. The South region was chosen because of contiguity and economic similarity.

of the urban center of mass of the ith region, $rcw_{i,k}$ is a graph-theoretically determined weighting factor for the kth city of the ith region, $X_{i,k}$ is the X-axis coordinate of city i,k, and $Y_{i,k}$ is the Y-axis coordinate. The method for determining the value of $rcw_{i,k}$ is discussed below. The properties of UCM_i (aside from the characteristics of any center of gravity measure), are that, because of the use of rail-net connectivity weights, it tends to lie near cities that are well-integrated into the regional rail net and far from cities not well connected by rail. The value of UCM_i and the X,Y coordinate pair for each city in the region is then used to calculate $d_{i,k}$. Therefore, EUC_i will be larger, the larger and more numerous are the above-threshold cities in the region, the closer these cities are to the effective center of mass, and the better-integrated is the rail net. Map 4 illustrates the alignment of the major Soviet rail lines.

Second, the agglomerative potential of each region is calculated by the formula

$$A_i = \sum_{j=1}^{18} (ucw_{i,j} \cdot EUC_i \cdot EUC_j)/dd_{i,j}^b$$

where A_i is the agglomerative potential of the ith region, $ucw_{i,j}$ is a graph-derived weight based on the portion of total connectivity of region i accounted for by region j, $dd_{i,j}$ is the distance between UCM_i and UCM_j, and b is a parameter to be determined.


SELECTED SOVIET RAIL LINES, 1978 – MAP-4
SOURCE: JOHN C. DEWDNEY, A GEOGRAPHY OF THE SOVIET UNION, 3rd. Ed., P. 129

The properties of A_i are that it will tend to be larger, the larger is the effective urban concentration in region i, the closer it is to large urban concentrations in other regions, and the better are region i's rail connections with other regions, especially those with large urban concentrations. For all these circumstances but the first, the Baltic is far more favorably situated than Central Asia.

No particular a priori restriction were placed on a and b, other than that they be positive numbers. Particular values were chosen by testing different combinations in the growth equation, and choosing the combination that yielded the best fit for each region. Due to the complexity of the function, only integer values were tried. As a result of restricting choice to integer values, nine different combinations were evaluated. The results of this procedure and their interpretation are discussed above in Chapter III.

Calculation of A_i presents a special problem when i=j. Moreover, $ucw_{i,j}$ is not a meaningful weight when i=j. Sheppard has argued that under these conditions one solution is to insert some positive value for $dd_{i,j}$ to maintain consistency with the mathematical definition of potential. The procedure used here is to insert a value of zero in the summation for the case where i=j. One interpretation of this procedure is that urban concentration within region i itself generates no potential. The interpretation suggested here is that A_i so computed measures the potential for

growth due to interregional connections.[‡‡] Obviously, as EUC_i gets larger, everything else being equal, so does A_i.

The connectivity weights used in calculating UCM_i and A_i were determined from a graph-theoretic analysis of the Soviet rail net.[‡‡‡] For UCM_i, a graph of each region was constructed with above-threshold cities as nodes and the inter-city rail net as edges. Intersections occurring at points other than threshold cities were treated as multiplications of the effective number of edges connecting the adjoining nodes. Based on this graph, a K_i by K_i connectivity matrix C_i was then constructed by entering a one for the l,m element if the lth city connects directly with the mth city, and a zero otherwise; diagonal elements are zero. The final connectivity matrix $CH_i = \sum_{h=1}^{\delta} C_i^h$, was calculated, where the entries in the summation, ΣC_i^h, are members of the series C_i, $C_i^2 = C_i' C_i$, $C_i^3 = C_i' C_i^2$,..., where $C_i^{\delta} = C_i' C_i^{\delta-1}$, CH_i has no zero elements, and δ, the diameter of the graph, is the smallest integer for which this is true.

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‡‡Alternative interpretations of the gravity model are discussed, e. g., in Harry W. Richardson, "agglomerative Potential: A Generalization of the Income Potential Concept," Journal of Regional Science 14 (December 1974), pp. 325-334 and Eric S. Sheppard, "Theoretical Underpinnings of the Gravity Hypothesis," Geographical Analysis 10 (October 1978), pp. 387-400.

‡‡‡The graph-theoretically derived procedures described below were taken from K. J. Kansky, Structure of Transportation Networks: Relationships Between Network Geometry and Regional Characteristics, Dept. of Geography Research Paper No. 84, University of Chicago (Chicago: University of Chicago Press, 1963), pp. 10-33 and Peter Haggett and Richard J. Chorley, Network Analysis in Geography (New York: St. Martin's Press, 1970), pp. 32-38.

The element 1,m in CH_i is the total number of ways one could travel from 1 to m (or m to 1, due to symmetry), by traversing a number of edges less than or equal to δ.

The sum of the elements in the kth row of CH_i is the total number of connections with δ or fewer edges for city k, with all cities in region i, or $tch_{i,k}=\sum_{l=1}^{K_i} ch_{i,k,l}$ where $ch_{i,k,l}$ is element k,1 of CH_i. Define $tch_i=\sum_{k=1}^{K_i} tch_{i,k}$. Then $rcw_{i,k}=tch_{i,k}/tch_i$. Thus $rcw_{i,k}$ has the property that $0<rcw_{i,k}<1$; for a city k with a relatively large number of intra-regional connections, $rcw_{i,k}$ lies close to one, relative to a city with fewer connections. Note that the value of $rcw_{i,k}$ cannot be compared directly to the equivalent index for a city in another region, since $rcw_{i,k}$ is sensitive, among other things, to the number of cities in a region. In addition, this measure is a scalar, without either directional or distance values. It is used only in providing transportation linkage weights to compute UCM_i.

The calculation of $ucw_{i,j}$ follows along similar lines. First, the interregional regional connectivity matrix CC is constructed in a manner analogous to the construction of the matrix C. In this process, regions are judged connected with neighboring regions if there is a rail line link between above-threshold cities in each region. This is invariably the case for the Soviet Union. Region i and region j are also treated as connected even if not adjoining, provided rail connections are possible between an above threshold city in region i and a similar city in

region j by transversing another region or regions, if no city in the intervening region(s) above the threshold size lies on the connecting route. A rule used to determine trans-regional connectivity is that the routing followed for such a linkage must not reverse its direction. This eliminates classifying as "connected" two regions that commute "directly" only by a labrynthian process, unlikely to be followed by actual freight or passenger traffic.

The final interregional connectivity matrix CCH is then calculated from CC using the same process described above for computation of CH_i. The i,j element of CCH is the number of different ways region i can be connected with region j with δ' or fewer edges, where δ' is the diameter of CC. Define $tcch_i = \sum_{j=1}^{18} cch_{i,j}$, where $cch_{i,j}$ is the i,j element of CCH. Then $ucw_{i,j}$ is defined as $ucw_{i,j} = cch_{i,j}/tcch_i$. Thus $ucw_{i,j}$ has the property $0 < ucw_{i,j} < 1$, is close to one if there are several linkage possibilities between regions i and j, and close to zero if there are few possibilities. Note that in general $ucw_{i,j}$ does not equal $ucw_{j,i}$.

Both the graph of intraregional connections and the graph of interregional connections were derived from Status of Railroads in the USSR 1 April 1976 (see footnote 4). Information from Status of Railroads was augmented by information of rail line completion dates given as annotations on a map titled USSR Railways, compiled by J. R. Yonge and published by the Quail Map Co., Exter, England, 1973. One concern with the approach taken here was

that the actual rail net connections changed during the course of the study.

The USSR Railways map showed that all intraregional ties between above-threshold cities were in place at the beginning of the study period, and that all interregional connectivity extant in 1977 was available at the beginning of the study period, except for the direct link between the North Caucasus region of the RSFSR and the South region of the Ukraine, made possible by the installation of a rail ferry in 1965. Thus, there was only one interruption in the connectivity measure.'' This was modeled in two ways. One, it was ignored, in the sense that the graph changed from 1965 to 1966, but there was no change in the modeling of a_t. Two, binary variables were used to allow for different coefficient weights for the two connectivity regimes and for the unrepresentative change in city populations between the 1969 and the 1970 figures (see Appendix A). The results of these alternatives are discussed in Chapter III. On the

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''Soviet rail construction during the period of this study consisted of providing connections to smaller cities (for example, the provision of rail service via ferry to Sakhalin in 1965), or in adding routes that, while undoubtedly were useful in terms of economic connections, were redundant from a graph-theoretic point of view. This is due to the binary nature of the connectivity. If regions i and j are already connected by a line between any pair of cities, one in each region, the regions are classified as connected. Adding another rail line between another city pair, one in each region, does not, therefore, change the connectivity matrix. A "redundant" connection of this sort, likely of considerable economic value, was added between Central Asia and the Volga-Viatskii region of the RSFSR in 1973, for example. The over-all impression one gets of Soviet rail construction during the period is that it consisted mainly of constructing feeder lines, and improving

whole, the graph-theoretic analysis seems stronger for cross-sectional study. Its usefulness in this study is possible in a large part due to the stability of the Soviet rail net over the course of the study period.

A comparison of the values of A_t calculated for the Baltic and for Central Asia reveals some interesting information. First, the values for the Baltic are consistently much larger than for Central Asia, though on a percentage basis the difference declined during the study period. This is in spite of the fact that there are more people living in above-threshold cities in Central Asia. The reason is due partly to the fact that cities are closer together in the Baltic, but mainly to the fact that the Baltic enjoys two locational advantages over Central Asia. First, it is located closer to other urban-industrial centers of the USSR. Second, the rail net servicing the Baltic is better connected, both in terms of the intra-regional ties and in terms of the interregional ties. It is argued above that these locational advantages are important for economic growth. This importance is reflected in the greater sensitivity of the Baltic growth equation to the addition of the a_t terms.

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the existing linkages.

BIBLIOGRAPHY

BIBLIOGRAPHY

Afanas'evskii, E. A. Legkaia promyshlennost': ekonomicheskie problemy razmeshcheniia (Light industry: economic problems of distribution). Moscow: "Mysl'," 1976. Cited by Dienes, Leslie. "Regional Economic Development." Paper presented at the Conference on the Soviet Economy Towards the Year 2000, Airlie House, Virginia, October 23-25, 1980.

Bandera, V. N., and Melnyk, Z. L., eds. The Soviet Economy in Regional Perspective. New York: Praeger Publishers, 1973.

Becker, Abraham S. "National Income Accounting in the USSR." In Soviet Economic Statistics, pp. 69-119. Edited by Treml, Vladimir G., and Hardt, John P. Durham, North Carolina: Duke University Press, 1972.

Bond, Daniel L. "Multiregional Economic Development in the Soviet Union: 1960-1975." Ph. D. dissertation, University of North Carolina, 1979.

Brown, A. J., and Burrows, E. M. Regional Economic Problems. London: George Allen and Unwin Ltd., 1977.

Bryan, Paige. "Large Contingent of Student Labor in the Nonchernozem Zone." Radio Liberty Dispatch RL 224/74. New York: Radio Liberty Committee, 1974.

Burghardt, Andrew F., ed. Development Regions in the Soviet Union, Eastern Europe, and Canada. New York: Praeger, 1975.

Campbell, Robert W. The Soviet-Type Economies: Performance and Evolution, 3rd ed. Boston: Houghton Mifflin Company, 1974.

Carey, David W. "Soviet Agriculture: Recent Performance and Furture Plans." In Soviet Economy in a New Perspective, pp. 575-599. Joint Economic Committee, 94th Congress, 2nd Session. Washington, D. C.: Government Printing Office, 1976,

Chandler, Clark J. "The Effects of the Private Sector on the Labor Behavior of Soviet Collective Farmers." Ph. D. dissertation, University of Michigan, 1978.

Cohn, Stanley H. "Soviet Replacement Investment: A Rising Policy Imperative." In Soviet Economy in a Time of Change, vol. 1, pp. 230-245. Joint Economic Committee, 96th Congress, 1st Session. Washington, D. C.: Government Printing Office, 1979.

Corbo, Vittorio. "Second Order Approximations for Estimating Production Functions." Annals of Economic and Social Measurement 5 (Winter, 1975): 65-75.

Demko, George J., and Fuchs, Roland J., eds. Geographic Perspectives in the Soviet Union. Columbus: Ohio State University Press, 1974.

Denison, Edward F. Why Growth Rates Differ: Postwar Experience in Nine Western Countries. Washington, D. C.: The Brookings Institution, 1967.

Desai, Padma. "The Production Function and Technical Change in Postwar Soviet Industry: A Reexamination." American Economic Review 66 (June 1976): 372-381.

Dewdney, John C. A Geography of the Soviet Union, 3rd ed. Oxford: Pergamon Press, 1971.

Dienes, Leslie. "Regional Variations of Capital and Labor Productivity in Soviet Industry." Journal of Regional Science 12 (December 1972): 401-406.

Eckaus, Richard S., and Parikh, Kerit S. Planning for Growth: Multisectoral, Intertemporal Models Applied to India. Cambridge, Mass.: MIT Press, 1968.

Ellman, Michael. Planning Problems in the USSR: The Contributions of Mathematical Economics to Their Solution 1960-1971. Cambridge: Cambridge University Press, 1973.

Emel'ianov, A. and Kushnirskii, F. "Dinamicheskaia model' razvitiia narodnogo khoziaistva respubliki" (A dynamic model of the development of a republic economy). Planovoe khoziaistvo 47 (November 1970): 76-84.

_____. "Raschet osnovnykh pokazatelei narodnokhoziaistvennogo plana s primeneniem ekonomiko-statisticheskikh modelei" (Calculation of the indexes of the national-economic plan using economic-statistical models). Planovoe khoziaistvo 49 (March 1972): 44-52.

Feshbach, Murray. "Prospects for Outmigration from Central Asia and Kazakhstan in the Next Decade." In Soviet Economy in a Time of Change, vol. 1, pp. 656-709. Joint Economic Committee, 96th Congress, 1st Session. Washington, D. C.: Government Printing Office, 1979.

Fuchs, Roland J. and Demko, George J. "Geographic Inequality Under Socialism." Annals of the Association of American Geographers 69 (June 1979): 304-318.

Gerachi, Vincent J. "Identification of Simultaneous Equation Models with Measurement Error." Journal of Econometrics 4 (January 1976): 263-283.

Gillula, James W. "The Economic Interdependence of Soviet Republics." In Soviet Economy in a Time of Change, vol. 1, pp. 614-676. Joint Economic Committee, 96th Congress, 1st Session. Washington, D. C.: Government Printing Office, 1979.

_____. "Input-Output Analysis." In The Ukraine Within the USSR: An Economic Balance Sheet, pp. 193-234. Edited by Koropeckyj, Ivan S. New York: Praeger, 1977.

_____. The 1966 Input-Output Tables for Soviet Central Asian Republics: Kirgizstan, Tadshikistan, and Uzbekistan. Chapel Hill-Durham: Duke University-University of North Carolina Occasional Papers on Soviet Input-Output Analysis, No. 18, 1976.

Goldhagen, Erich, ed. Ethnic Minorities in the Soviet Union. New York: Praeger, 1968.

Green, Donald W. "The Use of Econometric Methods in the Analysis of Centrally Planned Economies: The SRI-WEFA Experience." Journal of Comparative Economics 1 (September, 1977): 259-275.

Green, Donald W. and Higgins, Christopher I. SOVMOD I: A Macroeconomic Model of the Soviet Union. New York: Academic Press, 1977.

Grossman, Gregory. "Notes on the Illegal Private Economy and Corruption." In Soviet Economy in a Time of Change, vol. 1, pp. 834-855. Joint Economic Committee, 96th Congress, 1st Session. Washington, D. C.: Government Printing Office, 1979.

Gregory, Paul R. and Stuart, Robert C. Soviet Economic Structure and Performance. New York: Harper and Row, 1974.

Gruchman, Bohdan. "Delimitation of Development Regions in Centrally Planned Economies." In Development Regions

in the soviet Union, Eastern Europe, and Canada, pp. 1-13. Edited by Burghardt, Andrew F. New York: Praeger, 1975.

Haggett, Peter, and Chorley, Richard J. Network Analysis in Geography. New York: St. Martin's Press, 1970.

Holubnychy, Vsevolod. "Some Economic Aspects of Relations Among the Soviet Republics." In Ethnic Minorities in the Soviet Union, pp. 50-120. Edited by Goldhagen, Erich. New York: Praeger, 1968.

_____. "Spatial Efficiency in the Soviet Economy." In The Soviet Economy in Regional Perspective, pp. 1-44. Edited by Bandera, V. N. and Melnyk, Z. L. New York: Praeger, 1973.

_____. "Teleology of the Macroregions in the Soviet Union's Long Range Plans, 1920-1990." In Development Regions in the Soviet Union, Eastern Europe, and Canada, pp. 82-150. Edited by Burghardt, Andrew F. New York: Praeger, 1975.

Hooson, David. "The Outlook for Regional Development in the Soviet Union." Slavic Review 31 (September, 1972): 535-555.

Inkeles, Alex, ed. Social Change in Soviet Russia. Cambridge, Mass.: Harvard University Press, 1968.

_____. "Soviet Nationality Policy in Perspective." In Social Change in Soviet Russia, pp. 244-264. Edited by Idem. Cambridge: Harvard University Press, 1968.

Kansky, K. J. Structure of Transportation Networks: Relationships Between Network Geometry and Regional Characteristics. Chicago: University of Chicago, Department of Geography Research Paper No. 84, 1963.

Kachaturov, T. "Development of the Theory of Effectiveness of Capital Investment." Problems of Economics 21 (May 1978): 80-100.

Kmenta, Jan. Elements of Econometrics. New York: Macmillan, 1971.

_____. "On Estimation of the CES Production Function." International Economic Review 8 (1967) (June 1967): 180-189.

Kolosovskiy, N. N. "The Territorial-Production Combination (Complex) in Soviet Economic Geography." In Geographical Perspectives in the Soviet Union, pp. 105-138. Edited by Demko, George J, and Fuchs,

Roland J. Columbus: Ohio State University Press, 1974.

Koropeckyj, Ivan S. "Equalization of Regional Development in Socialist Countries: An Empirical Study." Economic Development and Cultural Change 21 (October 1972): 68-86.

_____. "Industrial Location Policy in the USSR During the Postwar Period." In Economic Performance and the Military Burden in the Soviet Union, pp. 232-295. Joint Economic Committee, 91st Congress, 2nd Session. Washington, D. C.: Government Printing Office, 1970.

_____. "Methodological Problems of Calculating National Income for Soviet Republics." Journal of Regional Science 12 (December 1972): 387-401.

_____. "Regional Resource Allocation, Growth, and Income Inequality Under Socialism." In The Soviet Economy in Regional Perspective, pp. 45-62. Edited by Bandera, V. N., and Melnyk, Z. L. New York: Praeger, 1973.

_____, ed. The Ukraine Within the USSR: An Economic Balance Sheet. New York: Praeger, 1977.

Kuznets, Simon. "Economic Growth and Income Inequality." American Economic Review 45 (March 1955): 1-28.

Lovell, C. A. Knox. "Estimation and Prediction with CES and VES Production Functions." International Economic Review 14 (October 1973): 676-692.

McAuley, Alastair. "Personal Income in the USSR: Republican Variations in 1974." In The USSR in the 1980s. Trends and Prospects, pp. 41-57. Edited by NATO, Directorate of Economic Affairs and Directorate of Information. Newtonville, Mass.: Oriental Research Partners, 1979.

Malinvaud, E. Statistical Methods of Econometrics. Chicago: Rand-McNally, 1966.

Margolin, A. B. Pribaltiiskii Ekonomicheskii Raion (The Baltic Economic Region). Moscow: Nauka, 1970.

Mil'ner, G., and Gilinskaia, E. "Interregional Regulation of the Population's Living Standard." Problems of Economics 18 (December 1975): 42-55.

Moorsteen, Richard, and Powell, Raymond P. The Soviet Capital Stock, 1928-1962. Homewood, Ill.: Irwin, 1966.

Morton, Henry W. "The Soviet Quest for Better Housing--An Impossible Dream?" In Soviet Economy in a Time of Change, vol. 1, pp. 790-810. Joint Economic Committee,

96th Congress, 1st Session. Washington, D. C.: Government Printing Office, 1979.

Nove, Alec. The Soviet Economy, 3rd ed. London: George Allen and Unwin, Ltd., 1968.

Paukert, Felix. "Income Distribution at Different Levels of Development: A Survey of Evidence." International Labour Review 108 (August-September 1973): 97-126.

Popadiuk, K. Obshchestvennoe proizvodstvo v period razvitogo sotsializma (Social production in the period of developed socialism). Tashkent: "Uzbekistan," 1979. Cited by Dienes, Leslie. "Regional Economic Development." Paper presented at the Conference on the Soviet Economy Towards the Year 2000, Airlie House, Virginia, October 23-25, 1980.

Powell, Raymond P. "The Soviet Capital Stock from Census to Census, 1960-1973." Soviet Studies 31 (January, 1979): 56-75.

Rapawy, Stephen. "Regional Employment Trends in the USSR: 1950 to 1975." In Soviet Economy in a Time of Change, vol. 1, pp. 600-617. Joint Economic Committee, 96th Congress, 1st Session. Washington, D. C.: Government Printing Office, 1979.

Richardson, Harry W. "Agglomeration Potential: A Generalization of the Income Potential Concept." Journal of Regional Science 14 (December 1974): 325-336.

_____. Regional Growth Theory. London: Macmillan, 1973.

Saushkin, Yu. G., and Kalashnikova, T. M. "Basic Economic Regions of the USSR." In Geographical Perspectives in the Soviet Union, pp 139-167. Edited by Demko, George J. and Fuchs, Roland J. Columbus: Ohio State University Press, 1974.

Shneiderov, A. "Vosproizvodstvennye proportsii kapital'nykh vlozhenii" (Reproduced proportions of capital investments) Voprosy ekonomiki (August 1975): 26-36.

Schroeder, Gertrude E. "Soviet Regional Development Policies in Perspective." In The USSR in the 1980s. Trends and Prospects. pp. 25-39. Edited by NATO, Directorate of Economic Affairs and Directorate of Information. Newtonville, Mass.: Oriental Research Partners, 1979.

_____. "Regional Differences in Incomes and Levels of Living in the USSR." In The Soviet Economy in Regional

Perspective, pp. 167-195. Edited by Bandera, V. N., and Melnyk, Z. L. New York: Praeger, 1973.

Schroeder, Gertrude E. and Severin, Barbara. "Soviet Consumption and Incomes Policies in Perspective." In Soviet Economy in a New Perspective, pp. 620-660. Joint Economic Committee, 94th Congress, 2nd Session. Washington, D. C.: Government Printing Office, 1976.

Sheehy, Ann. "Some Aspects of Regional Development in Soviet Central Asia." Slavic Review 31 (September 1972): 555-563.

Shishko, Robert. Defense Budget Interactions Revisited. Rand Report P-5882. Santa Monica: The Rand Corporation, 1977.

Silver, Brian. "Levels of Sociolcultural Development Among Soviet Nationalities: A Partial Test of the Equalization Hypothesis." American Political Science Review 68 (December 1974): 1618-1637.

Stangert, Per O. "Economies of Scale in Soviet Industry: Intertemporal, Regional, and Branch Analysis." In Studies in Soviet Input-Output Analysis, pp. 113-152. Edited by Treml, Vladimir G. New York: Praeger, 1977.

Theil, H. and Goldberger, A. S. "On Pure and Mixed Statistical Estimation in Economics." International Economic Review 2 (January 1961): 65-71.

Treml, Vladimir G., ed. Studies in Soviet Input-Output Analysis. Praeger: New York, 1977.

Treml, Vladimir G., Gallik, Dimiti M., and Kostinsky, Barry L. "1966 Ex Post Input-Output Tables for the USSR: A Survey." In Studies in Soviet Input-Output Analysis, pp 1-67. Edited by Treml, Vladimir G. New York: Praeger, 1977.

Treml, Vladimir G. and Hardt, John P., eds. Soviet Economic Statistics. Durham, North Carolina: Duke University Press, 1972.

Udovenko, V. "Changes in the Location of Productive Forces of the USSR." Problems of Economics 21 (July 1978): 57-78.

U. S., Central Intelligence Agency. Soviet Agricultural Commodity Trade 1960-1976: A Statistical Survey. Washington, D. C.: n. p., September, 1978.

_____. Status of Railroads in the USSR, 1 April 1976. Washington, D. C., n. p., 1976.

_____. USSR Agriculture Atlas. Washington, D. C.: n. p., 1974.

U. S. Department of Commerce, Bureau of the Census. Agricultural Subsidies in the Soviet Union. By Treml, Vladimir G. Foreign Economic Report No. 15. Washington, D. C.: Government Printing Office, 1978.

_____. Population Projections by Age and Sex: For the Republics and Major Economic Regions of the USSR 1970 to 2000. By Baldwin, Godfrey S. Foreign Demographic Analysis Division Series P-91, No. 26. Washington, D. C.: Government Printing Office, 1979.

_____. The Regional Distribution of Fixed Capital in the USSR. By Gillula, James W. Foreign Economic Report No. 17. Washington, D. C.: Government Printing Office, 1980.

U. S. Department of Commerce, Environmental Data Service (formerly Weather Bureau). Monthly Climatic Data for the World. Ashville, North Carolina: n.p., monthly 1959-1977.

Varlamov, V. S. "Geographic Features of Interregional Ties Between the Territorial-Production Complexes of the Western and Eastern Regions of the USSR." In Geographical Perspectives in the Soviet Union, pp. 168-182. Edited by Demko, George J. and Fuchs, Roland J. Columbus: Ohio State University Press, 1974.

Vainshtein, Al'bert L. Narodnyi dokhod Rossii i SSSR (National income of Russia and the USSR). Moscow: Nauka, 1969.

Vasilevskiy, L. I. "Some Possible Approaches to the Study of the Territorial Structure of the Economy Using Mathematical Methods." In Geographic Perspectives in the Soviet Union, pp. 84-97. Edited by Demko, George J. and Fuchs, Roland J. Colombus: Ohio University Press, 1974.

Vishniakova, I. V. "O pokazatelkh urovnei territorial'nogo razvitiia khoziaistva (Na primere Iugoslavii)" (On indexes of the level of territorial economic development [The example of Yugoslavia]). In Regional'noe razvitie i geograficheskaia sreda (Regional development and the geographic dimension), pp. 422-434. Edited by Aruchin, V. A. Moscow: n.p., 1971.

Wagener, Hans-Jürgen. Regional Output Levels in the Soviet Union. Radio Liberty Research Paper No. 41. New York:

Radio Liberty Committee, 1971.

_____. The RSFSR and the Non-Russian Republics: An Economic Comparison. New York: Radio Liberty Committee, n. d.

_____. "Rules of Location and the Concept of Rationality: The Case of the USSR." In The Soviet Economy in Regional Perspective, pp. 63-103. Edited by Bandera, V. N., and Melnyk, Z. L. New York: Praeger, 1973.

Whitehouse, F. Douglas. "Demograpphic Aspects of Regional Development in the USSR." In The Soviet Economy in Regional Perspective, pp. 154-166. Edited by Bandera, V. N., and Melnyk, Z. L. New York: Praeger, 1973.

Williamson, Jeffery G. "Regional Inequality and the Process of National Development: A Description of the Patterns." Economic Development and Cultural Change 13 (July 1965, Part II): 3-82.

Wimbush, S. Enders, and Ponomareff, Dmitry. Alternatives for Mobilizing Soviet Central Asian Labor: Outmigration and Regional Development. Santa Monica: The RAND Corp., R-2476-AF, 1979.

Woroniak, Alexander. "Regional Aspects of Soviet Planning and Industrial Organization." In The Soviet Economy in Regional Perspective, pp. 261-305. Edited by Bandera, V. N., and Melnyk, Z. L. New York: Praeger, 1973.

Soviet Statistical Handbooks (USSR and Republics)

USSR

Tsentral'noe statisticheskoe upravlenie pri Sovete Ministrov SSSR. Narodnoe khoziaistvo SSSR v 19** (The national economy of the USSR in 19**) [NARKHOZ 19**]. Moscow: Gosstatizdat or Statistika, 1961-1978. A series of handbook covering the years 1960-1977.

_____. Narodnoe khoziaistvo SSSR za gody Sovetskoi vlasti (The national economy of the USSR in the years of Soviet power) [NARKHOZ 1976]. Moscow: Statistika, 1977.

_____. Strana Sovetov za 50 let (The land of the Soviets during 50 years) [NARKHOZ 1966]. Moscow: Statistika,

1967.

Central Asia.

Tsentral'noe statisticheskoe upravlenie pri Sovete Ministrov SSSR. Sredneaziatskoe statisticheskoe upravlenie. Narodnoe khoziaistvo Srednei Azii v 1963 godu (The national economy of Central Asia in 1963) [NKSA]. Tashkent: Uzbekistan, 1964.

Estonia.

Tsentral'noe statistaticheskoe upravlenie pri Sovete Ministrov Estonskoi SSR. Estonskiaia SSR za gody Sovetskoi vlasti (The Estonian SSR during the years of Soviet power) [EZGSV]. Tallin: Statistika, 1967.

_____. Narodnoe khoziaistvo Estonskoi SSR v 19** (The national economy of the Estonian SSR in 19**) [NKE 19**]. Tallin: Statistika, 1968-1972; Eesti raamat, 1973 and 1976-1978. A series of statistical handbooks for 1967-1971 and 1972 and 1974-1977.

_____. Sovetskaia Estonia za 25 let (Soviet Estonia during 25 years) [SEZ25L]. Tallin: Eesti raamat, 1965.

Kirgizia

Tsentralnoe statisticheskoe upravlenie pri Sovete Ministrov Kirgizskoi SSR. Kirgizstan v tsifrakh (Kirgizia in figures) [KVTs]. Frunze: Kyrgystan, 1971.

_____. Kirgizstan za 50 let Sovetskoi vlasti (Kirgizia during 50 years of Soviet power) [KZ50LSV]. Frunze: Kyrgystan, 1967.

_____. Kirgizstan za gody Sovetskoi vlasti (Kirgizia during the years of Soviet power) [KZGSV70/77]. Frunze: Kyrgystan, 1970 and 1977. Two handbooks were published with the same title, in the indicated years.

_____. Narodnoe khoziaistvo Kirgizskoi SSR in 19** (The national economy of Kirgizia in 19**) [NKKi 19**]. Frunze: Statistika and Kyrgystan, 1961-1962, 1964, 1968, and 1972-1976. A series of handbooks for 1960, 1961, 1963, 1967, and 1971-1975.

Latvia

Tsentral'noe statisticheskoe upravlenie pri Sovete Ministrov Latviiskoi SSR. Ekonomika i kul'tura Sovetskoi Latvii (The economy and culture of Soviet Latvia) [EKSL]. Riga: Statistika, 1966.

_____. Latviiskaia SSR v tsifrakh v 19** godu (The Latvian SSR in figures in 19**) [LVTs 19**]. Riga: Gosstatizdat, 1962; and Statistika, 1969,1971. Handbooks for 1961, 1968, and 1969.

_____. Narodnoe khoziaistvo Latviiskoi SSR v 19** (The national economy of the Latvian SSR in 19**) [NKL 19**]. Riga: Statistika, 1972, 1972; Liesma, 1973-1978. A series of handbooks for 1970-1977.

_____. Narodnoe hkoziaistvo Sovetskoi Latvii (The national economy of Soviet Latvia) [NKSL]. Riga: Statistika, 1968.

_____. Sovetskaia Latviia v tsifrakh (Soviet Latvia in figures) [SLVTs]. Riga: Statistika, 1965.

_____. Sovetskaia Latviia za 25 let (Soviet Latvia during 25 years). [SLZ25L]. Riga: Statistika, 1965.

Lithuania

Tsentral'noe statisticheskoe upravlenie pri Sovete Ministrov Litovskoi SSR. 25 let Sovetskoi Litvy (25 years of Soviet Lithuania) [25LSLi]. Vil'nius: Statistika, 1965.

_____. Ekonomika i kul'tura Litovskoi SSR v 19** (The economy and culture of the Lithuanian SSR in 19**) [EKLi 19**]. Vil'nius: Statistika, 1970, 1971, and 1973-1974; Mintis, 1975-1976 and 1978. A series of statistical handbooks for 1969, 1970, 1972-1975, and 1977.

_____. Ekonomika i kultura Litovskoi SSR 50 (Economy and culture of the Lithuanian SSR, 50) [EKLi50]. Vil'nius: Statistika, 1967.

_____. Narodnoe khoziaistvo Litovskoi SSR v 1965 godu (The national economy of Lithuania in 1965) [NKLi 1965]. Vil'nius: Statistika, 1966.

Tadzhikistan.

Tsentral'noe statisticheskoe upravlenie pri Sovete Ministrov Tadzhikskoi SSR. Narodnoe khoziaistvo Tadzhikskoi SSR v 19** (The national economy of the Tadzhik SSR in 19**) [NKT 19**]. Dushanbe: Statistika, 1963, 1965-1966, 1969, and 1970; Soiuzuchetizdat, 1972; Irfon, 1973, 1976-1977, and 1979. A series of statistical handbooks for 1962, 1964-1965, 1968-1969, 1971-1972, and 1975-1977.

_____. Sovetskii Tadzhikistan za 50 let (Soviet Tadzhikistan during 50 years) [STZ50L]. Dushanbe: Irfon, 1975.

Uzbekistan.

Tsentral'noe statisticheskoe upravlenie pri Sovete Ministrov Uzbekskoi SSR. Narodnoe khoziaistvo Uzbekskoi SSR v 19** (The national economy of the Uzbek SSR in 19**) [NKU 19**]. Tashkent: Uzbekistan, 1966, 1968, 1970, 1970, 1971-1972, 1976, 1978. A series of statistical handbooks for 1965, 1967-1971, 1975, and 1977.

_____. Narodnoe khoziaistvo Uzbekskoi SSR za 50 let (The national economy of the Uzbek SSR during 50 years) [NKUZ50L]. Tashkent: Uzbekistan, 1967.

_____. Narodnoe khoziaistvo Uzbekskoi SSR za 60 let (The national economy of the Uzbek SSR during 60 years) [NKUZ60L]. Tashkent: Uzbekistan, 1977.

_____. Sovetskii Uzbekistan za 40 let (Soviet Uzbekistan during 40 years) [SUZ40L]. Tashkent: Uzbekistan, 1964.

_____. Uzbekistan za 7 let (1959-1965gg.) [Uzbekistan during 7 years (1959-1965)] [UZ7L]. Tashkent: n.p., 1966.


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